THERMOTRON
CORPORATION

F-32-CHV-30C

INSTRUCTION MANUAL

#5

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THERMOTRON CORPORATION

Holland, Michigan

INSTRUCTION MANUAL

- For -

THERMOTRON ENVIRONMENTAL CHAMBER

Temperature - Vibration

Model No. F-32-CHV-30C

Serial No. 5670

-Manufactured For-

TELEDYNE SYSTEMS

19601 Nordhoff

Northridge, California

Purchase Order No. Z98-74235

COMPONENT LITERATURE

Literature has been supplied for all the major components used in manufacturing this equipment. This literature is a valuable source of information, both for understanding the operation of the component and for reference in the future.

An understanding of the information contained in this literature is also essential to the proper operation of this equipment. This information is complementary to the information contained in the equipment instruction manual, and both should be thoroughly read and understood before attempting to operate the equipment.

This manual consists of selected sections pertaining to the options and variations of your specific equipment. Accordingly some pages or sections of this manual appear omitted because of non-sequential page numbers. These pages do not apply to the operation of your equipment.

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DATA SUMMARY SHEET

MODEL F-32-CHV-30C

TEMPERATURE RANGE:

-100°F. to +350°F.

TEMPERATURE TOLERANCE:

± 2°F.

VOLTAGE:

460/3/60 80 F.L.A.

COMPRESSOR DATA:

Refrigerant	Make	Model	H.P.
R-13	Copeland	4RL1-1500-TSK	15
R-502	Copeland	4RL1-1500-TSK	15

REFRIGERANT CHARGE:

R-13 - 100 P.S.I.G. "Equalized" pressure at stable ambient temperature.

R-502 - 15 lbs. actual weight.

HEATING EQUIPMENT:

Three (3) open coil type, heating elements 4.5 K.W. at 440 V., Part #EL-1102-4.

INSTRUMENTATION:

Make: Honeywell Programmer-Recorder-Controller

Model: 152

Range: -125°F. to +375°F.

Chart: 16381

DATA SUMMARY SHEET

INSTRUMENTATION: (Continued)

Make: Paragon Time Clock

Model: 23002-0S

GENERAL DESCRIPTION

This manual is provided to acquaint the operator with Thermotron equipment. The enclosed schematics will enable an understanding of how the various conditions and control functions are achieved. Thermotron engineering and "know-how" are built into each assembly of environmental test equipment. This assures dependable operation of specific functional tests. Minimum maintenance will be achieved through periodic checks and proper care.

This chamber is a completely self-contained and interconnected temperature-vibration chamber, capable of producing and maintaining the temperature conditions outlined. The materials, component parts, mechanical assemblies and workmanship, used in the construction of this chamber, are of the best commercial quality consistent with the performance requirements of this specification. All protective features normally incorporated in electrical and mechanical apparatus of this type have been used. The system is completely safety-interlocked to prevent damage to the chamber in case of failure of any part.

GENERAL DESCRIPTION
Continued

POWER:

The chamber is designed to operate on the specific service supplied by the customer. One source of power is necessary for connection to the chamber and terminates at the main power terminal block located inside of the electrical compartment.

All of the major components, requiring large amounts of current, such as the compressors, heaters, and circulator motor, are operated from the main power source. Each circuit has its branch circuit protection. The control circuit is operated from a 115V source. This source is supplied from the main power source by a step-down transformer. (Refer to electrical schematic.)

Control function switches, equipped with neon indicating lights, are readily accessible on the electrical control panel, or remote console, providing a means of selecting the desired operating conditions.

HIGH VOLTAGE WARNING:

This equipment is supplied with a high voltage power source and should be serviced or adjusted only by qualified personnel.

GENERAL DESCRIPTION
(Continued)

INTERNAL LINER: Stainless steel Series 300, high nickel content, non-magnetic type, assures rust-proof quality. Interior seams are hermetically sealed. No wood or wood-like materials have been used.

EXTERIOR: The exterior of the chamber is a structural unit consisting of a welded angle framework. The machinery section is equipped with removable covers for servicing the equipment. The finish is industrial enamel sprayed over a cleaned and primed surface.

INSULATION: The best available material is provided. The "Ultra-Lite" non-settling fiberglas is ideal for this application with a "K" factor of .25. A hermetic seal exists between the test compartment and the insulation.

DOOR & HARDWARE: The door has been designed to provide full access to the work space. It is complete with neoprene or silicone gaskets and clamping latches. Hardware is heavy duty, adjustable, and designed for the application.

GENERAL DESCRIPTION
(Continued)

AIR CIRCULATION: The fans are located clear of the test space. This location permits diffused air flow. Baffles and guards are provided for the air circulators. The motors are externally located and have stainless steel shafts connecting to the fans. No bearings are in the test space.

HEATING: Nichrome heating elements are provided for instant heat. These elements are quick to respond to instrument demand. The minimum residual heating effect allows the best stability of controlled conditions. The heaters are located behind baffling to prevent direct radiation to the objects on test.

CAPACITY CONTROL: Controls are provided for fully regulating the heating or cooling effects needed to balance load conditions.

ELECTRICAL: Compressors and heaters operate on the main power service. All electrical components, whenever possible, are contained in a separate panel. All wiring is identified and either laced or enclosed in conduit. Pilot lights with engraved identification tabs indicate major operating components. All circuits are protected with heaters or fuses. Electrical system meets N.E.M.A. Standards.

GENERAL DESCRIPTION
(Continued)

LIGHT: Interior lights are installed inside the test chamber. The lights are controlled by a switch wired into the control circuit.

WINDOW: Multi-pane window assemblies with all tempered panes are provided in the chamber. The assemblies are hermetically sealed with a chemical dehydrator provided within the separating frames to insure continued dryness. (See assembly drawing for window size and location).

ACCESSORY PENETRATIONS: A stainless steel tube is used to penetrate through the wall thickness. Heliarc welding seals it to the liner. Ports may be located in the walls and door of the chamber. (Refer to the Assembly Drawing for port locations).

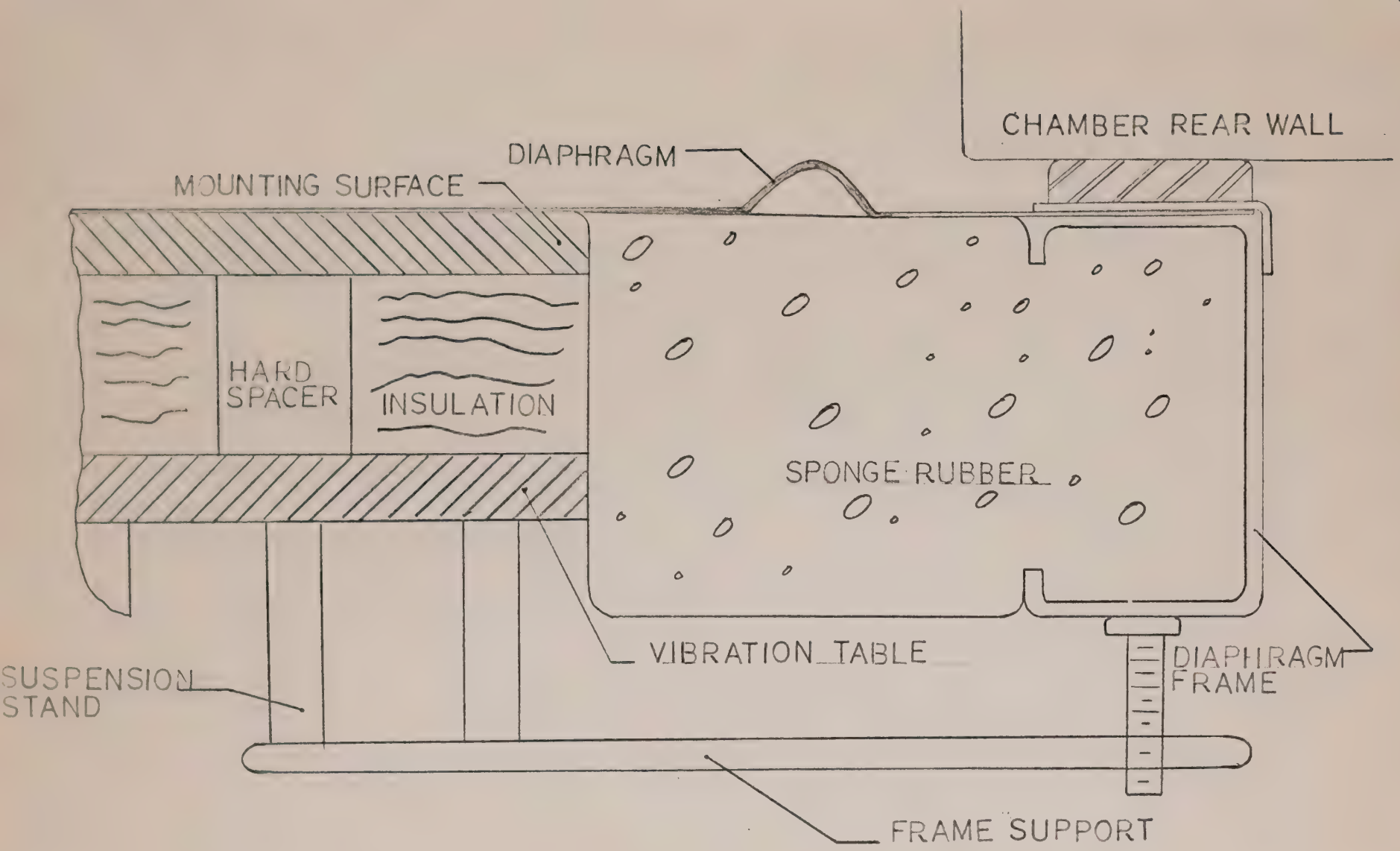
INSTRUMENTATION: Instruments are tailored to specific performance and control desired. Accuracy and function determine instrument selection.

GENERAL DESCRIPTION

VIBRATION

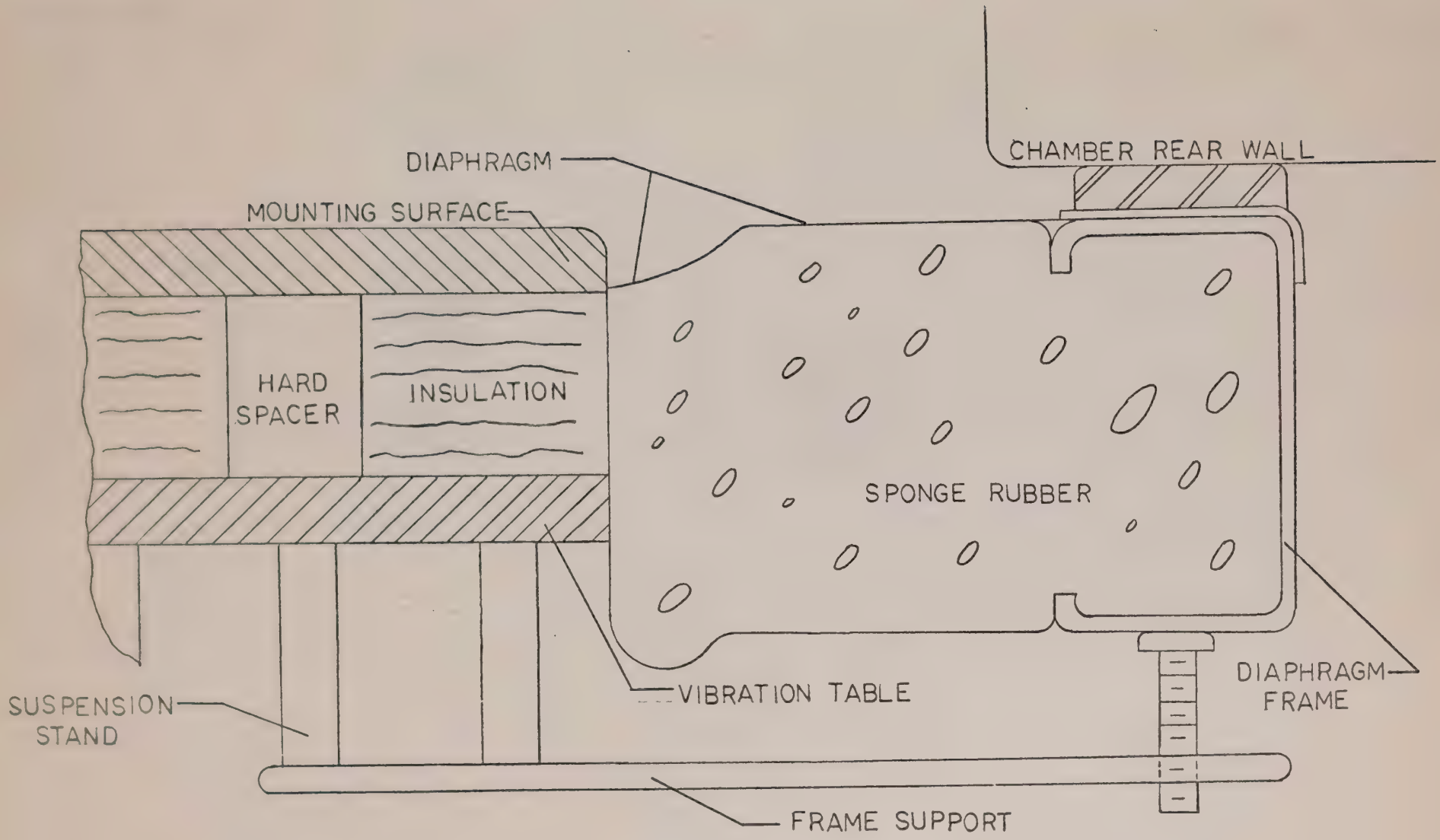
The Thermotron "AGREE" chamber is used to perform combined temperature and vibration test programs. The vibration port (open bottom) is built to accept a diaphragm and frame. The diaphragm material is silicone impregnated fiberglas. The silicone diaphragm is sized with enough edge material to allow free movement of the shaker head. The diaphragm is flexible under all temperature conditions. The diaphragm closes the entire bottom of the chamber, wall to wall, and across the top of the vibration machine. The diaphragm is mounted to a retainer frame. The diaphragm and frame are easily removed from the chamber. On removal, the vibration machine carries the diaphragm and retainer frame with it. This allows you to remove the shaker and its product load without raising or lowering the chamber.

It is suggested that an insulating spacer panel (1½" thick) be placed on the shaker head to minimize thermal transfer between the vibration machine and the test compartment. This chamber has been equipped with an 8 channel "Tape-command" tape programmer, one channel of which shall be used for stopping and starting the vibration shaker. (Refer to the tape command instructions for programming procedures.)



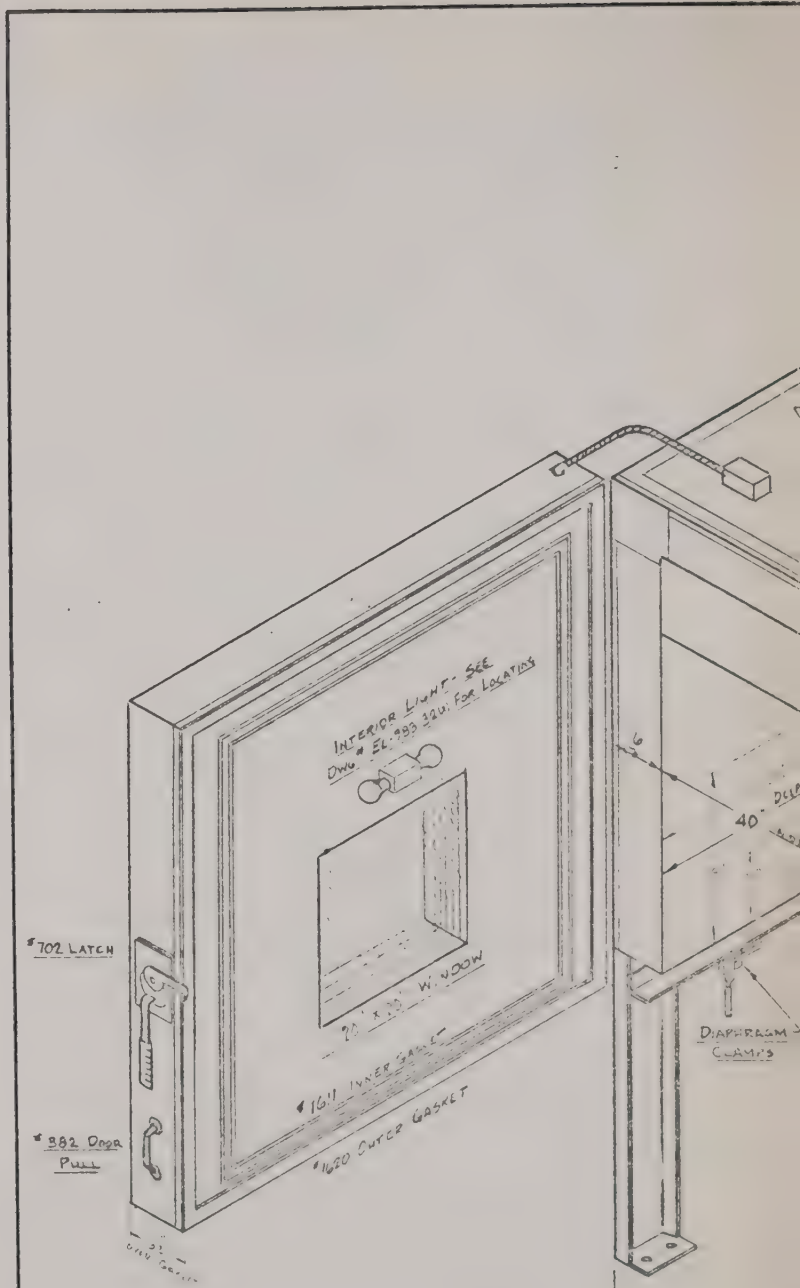
1.6.1.5

DIAPHRAGM INSTALLATION METH[illegible] I



1.6.1.6

DIAPHRAGM INSTALLATION METHOD II



DIAPHRAGM FRAME ASSEMBLY - AND VIBRATION SKID KIT NOT SHOWN - REQ'D (1) EACH

FOR

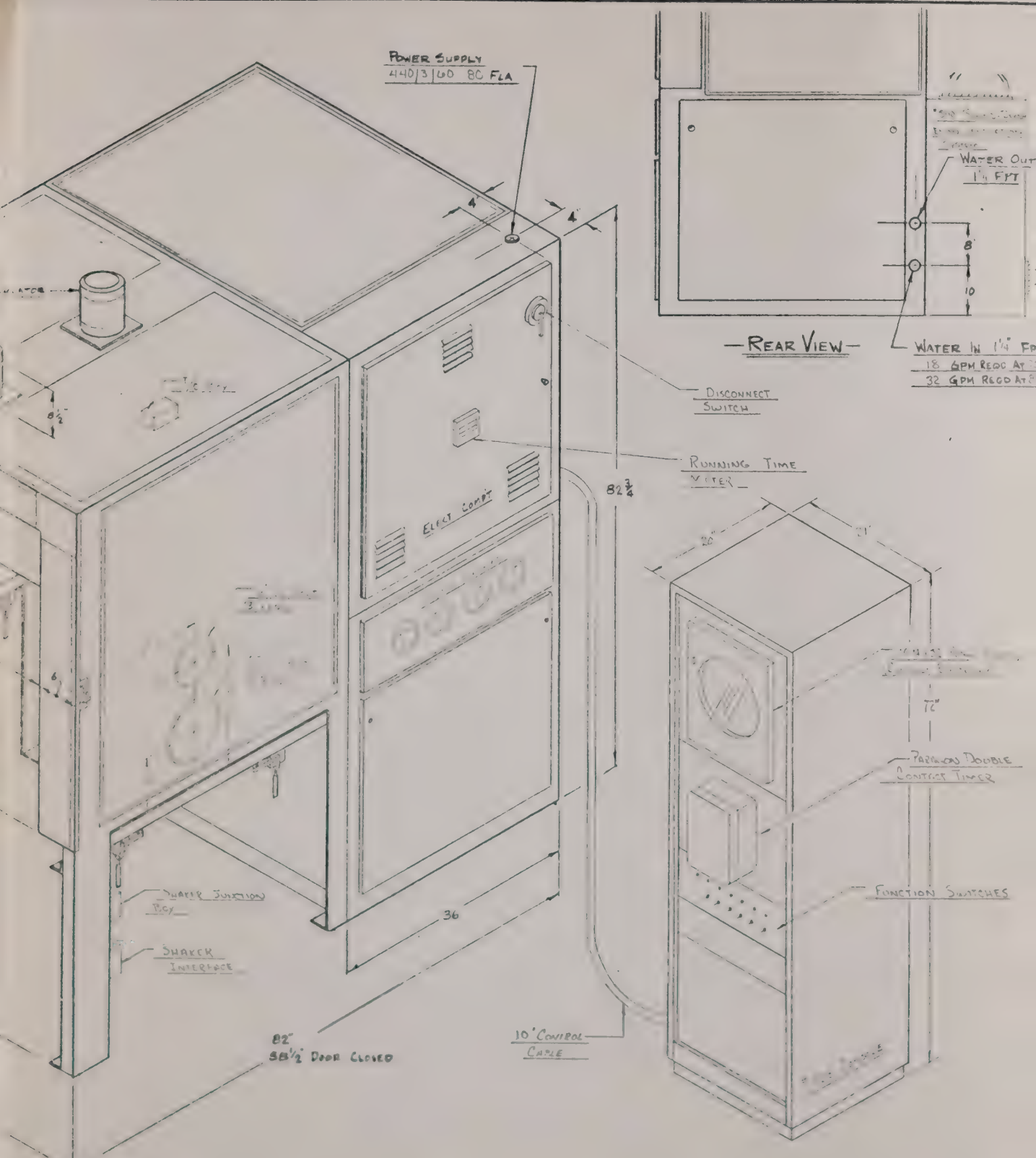
TELEDYNE SYSTEMS

NORTHRIDGE, CALIFORNIA P.O. # 378-70235

TEMPERATURE RANGE: -100°F TO +350°F

FINISH: THERMOTECH BLUE

T/C FORM # 5



A		C		MATERIAL	THERMOTRON CORP
B		D			HOLLAND, MICHIGAN U.S.A.
DRAWN BY	DATE	SCALE	APPROVED	MODEL F-32-CHV	ASSEMBLY

AIR CIRCULATION

Air circulation is provided by two propeller-type fans, driven by externally located ball bearing motors. Specially machined, stainless steel motor shafts directly drive the circulator fans in the test space. There are no bearings within the test space. (The bearings of the electric motors are life lubricated and require no lubrication). The conditioned air is directed to a baffle, which distributes it evenly throughout the chamber.

CIRCULATOR FAN WARNING:

The circulator switch should be off any time the chamber door is open. The circulator fan is designed for a mid-chamber suction action and is a potential hazard to anyone working near it.

F-32 EQUIPMENT DATA

The Model Number defines the basic chamber - F-32-CHV-30C.

F - Front door opening.

32 - 32 cubic feet of test space.

C - Cooling.

H - Heating.

V - Vibration ("Agree" type, designed to be compatible with a vibration machine).

30C - 15 horsepower primary system, and a 15 horsepower secondary system. (In combination to comprise a low-temperature, cascade cooling system.)

LOCATING INSTRUCTIONS FOR AGREE CHAMBERS

In order to effect an installation that will be permanently satisfactory, "AGREE" type test chambers should be securely fastened to the floor.

Over a period of time, temperature cycling within the chamber, combined with the effects of ambient vibration and temperature variations, can move the chamber out of its original position. This can stress plumbing and conduit connections, and may result in misalignment of the vibration test machine and chamber door.

Six tie-down positions are provided on each chamber--- two on each chamber front leg, and one on each chamber rear leg. In addition, there are four tie-down points on the machinery section. When the machinery section is remoted, all four machinery section tie-down points should be used. When the machinery section is attached to the chamber, only the two rear tie-downs need be used. These tie-down points are also used for shipping. Note their position prior to removing the chamber from its shipping platform. The best method of lagging the chamber to the floor should be determined prior to locating the unit.

The chamber should also be properly aligned and leveled. It may be necessary to shim the unit in order to achieve this. The front legs of the chamber are properly aligned when the chamber door is square with the chamber itself. This condition is achieved by moving the front legs of the chamber towards or away from each other as required. The hinges for the door are factory-aligned and usually do not shift thereafter. The door latch assembly is adjustable and should not be used as a reference for alignment.

Prior to fastening the unit to the floor, recheck the unit for leveling and door alignment.

Installation of water lines and electrical conduit from the service connection to the chamber, and installation of the vibration test machine should follow final positioning of the chamber itself.

LOCATING INSTRUCTIONS FOR L.A.B. SHAKERS

The vibration test machine is to be located within the chamber test space in such a manner that the top surface of its table will be geometrically centered with respect to the side walls of the chamber.

A flexible diaphragm is provided with the chamber which will mate with the table of the vibration test machine and a special rack on the chamber. This diaphragm provides a hermetic seal around the edges of the vibration table. Optional brackets are available to offer a means of supporting the diaphragm assembly when the vibration test machine is outside the chamber (during test set-up, etc.).

The vibration test machine is properly oriented when its two torsion bar adjustment studs face outward from the test chamber. (These studs are located on the lower front panel of the machine's base, one on either side). The manual electrical control box and power cord will then be on the right-hand side of the machine for convenient access to the shaker receptacle on the chamber. Two of the wheels on the machine are equipped with locking screws; these screws should also be located on the front side of the unit to insure accessibility.

The wheels of the vibration test machine are V-grooved to mate with a special steel track which is usually provided with each unit (tracks are optional from L.A.B.). These tracks provide a means of easily moving the vibration test machine into and out of the chamber without having to recenter the unit each time it is reinstalled. If the tracks are to serve their intended purpose, they must be fastened to the floor securely. Two pieces of angle iron, ½" x ½" x 3", may be fastened on the top and towards the rear of both tracks in order to provide a back-stop for the vibration test machine when it is rolled into the chamber.

For best results mark the proper position for the track with the vibration test machine and the diaphragm assembly properly located within the chamber. If the back-stops are to be included, locate them behind the rear wheels (tight against the wheels) of the vibration test machine and also mark their position at this time.

INSTALLATION INSTRUCTIONS

To insure proper operation Thermotron chambers should be installed on a solid level foundation.

NOTE: In moving or re-locating the chamber never tip more than 45 degress without special instructions from the manufacturer.

ELECTRICAL: Refer to electrical schematic and provide proper power supply. Connect to terminals as indicated and check rotation of circulator motor for correct fan rotation.

REFRIGERATION:

1. When compressor body is externally spring-mounted, remove shipping blocks and loosen hold-down bolts or nuts so compressor floats freely on springs.

2. When compressor body is rigid-mounted externally, it is internally spring-mounted and shipping blocks and hold-down bolts are not used.

3. All refrigeration circuit service valves must be checked for correct operating position by a qualified refrigeration mechanic.

4. Check compressors oil level in sight glass (1/3 to 2/3 full when operating).

INSTALLATION INSTRUCTIONS

PLUMBING: Provide and connect water supply to water inlet, line size equal to or larger than inlet fitting provided on the chamber. Connect drains to waste water line. Do not make final connection to water inlet fitting on chamber until any newly-installed line has been flushed thoroughly to remove any pipe compound, metal chips, or foreign matter. Where more than one chamber is operated, be sure the water supply and draining lines are sized large enough to handle the combined water requirements of the chamber.

Water pressure on an open drain type water cooling system shall be a minimum of 35 lbs. and a maximum of 100 lbs. On any type of closed system where the outlet (drain side) is not open, the OUTLET pressure is NOT TO EXCEED 50 lbs.

NOTE: Allow sufficient space around the equipment for servicing.

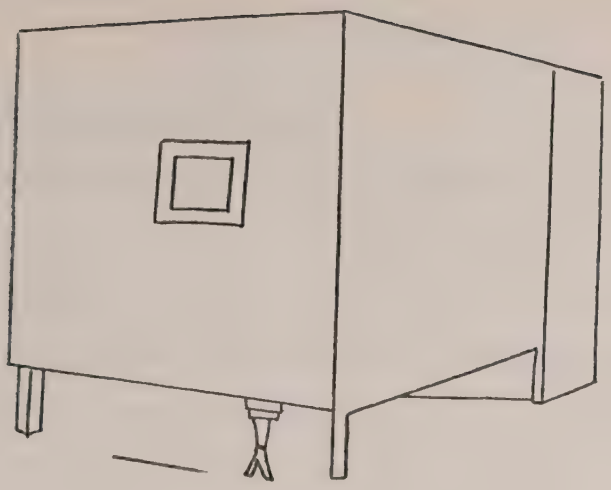
INSTRUMENTS: When instruments are shipped separately (because of packing or shipping reasons), the mounting clamps and bolts, with the charts, ink, and accessories, will be found in the instrument package.

Refer to electrical schematic and connect wiring as indicated. Brackets or clamps are provided within the test space for locating and supporting the sensing elements -- thermocouples or instrument sensing bulbs.

INSTALLATION INSTRUCTIONS
(Continued)

It is extremely important when installing the chamber, to shim the front legs of the chamber so the chamber sits level and the door closes properly. If the front legs are not properly leveled and squared at the time of installation, the front door will be racked; usually so it hangs low on the latch side. This can be corrected by proper shimming, and if necessary, a jack can be placed under the latch side of the door to lift the door into the proper position. This operation will move the leg on the hinge side into the proper position to hold the door in place. It may be necessary to lift the door slightly above the desired position.

With the door properly adjusted, the front legs should be securely anchored to the building floor using the holes provided in the bottom of the legs. With the chamber securely anchored, the door should then be checked for proper closing and operation.



THERMOTRON CORPORATION

Holland, Michigan

THERMOTRON "AGREE" CHAMBER
DOOR ALIGNMENT INSTRUCTIONS

Step I — Fasten the machinery package to the floor through the four provided tie-down pads. (Do not fasten either front leg.)

Step II — Use a step jack to raise the latch side of the door until it is approximately 1/8" higher than the body of the chamber.

Step III — This will properly position the leg on the hinge-side of the door. Secure this leg to the floor.

Step IV — Install the diaphragm or floor plug. Move the leg on the latch side of the chamber to attain the proper clearance between the diaphragm and the diaphragm rails.

Step V — Secure the leg on the latch side of the chamber to the floor.

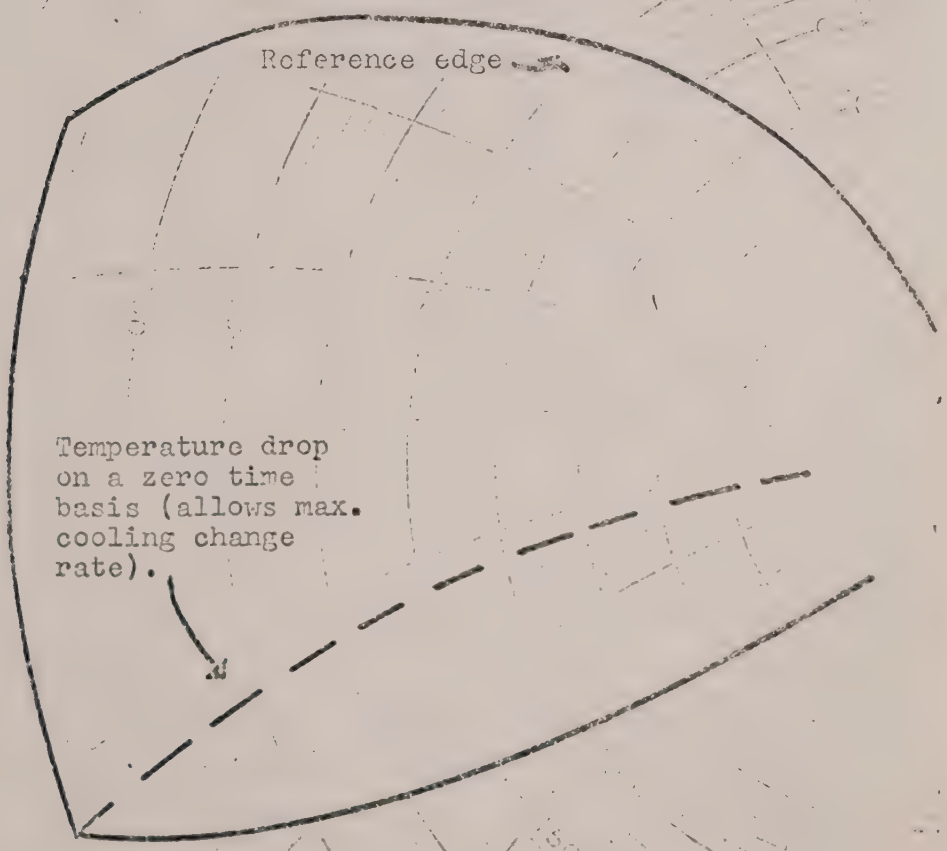
See above sketch.

INSTRUMENTATION

PROGRAMMER-RECORDER-CONTROLLER:

The controller instrument of this chamber is a Honeywell Model 152 "Electronik". The control function is an electro-pneumatic operation. Refer to the Honeywell Instruction Manual for maintenance and operating instructions. Proportional control of both the heating and cooling is achieved with peneumatic interrupters, which are activated by the Honeywell Controller. By reference to the Electrical Schematic and the Honeywell Manual, it can be seen how control demand is initiated and the complete sequence is accomplished.

Template for max. rise of cam on time program controller in the series 152 case with electric cam drive.



NOTE: The slope of any cam rise should always be within the slope represented by the reference edge of the template.

"AGREE" PROGRAMMING ON HONEYWELL 12" CAM PROGRAMMERS
("452" and "152" Series)

Due to the design of the mechanical cam follower on the Honeywell "152" and "452" instruments, the cam is limited to the maximum rise as described in the Honeywell and Thermotron manuals. On a 24-hour cam revolution (standard) this rate of climb is limited to 3 1/3 hours from the lowest point to the highest point. This rise is equivalent to the following change rates on the two standard charts listed below.

Chart No.	Chart Range	Chart Span	24-Hour Revolution
14950	-110°F. to +360°F.	470°F.	2.35°F/Min.
16381	-125°F. to +375°F.	500°F.	2.5°F/Min.

In many programs this rate of climb is unsatisfactory. This is especially true in "AGREE" type testing where 9°F. per minute rates are required. To allow for various cam rise requirements, Honeywell has provided a cam gear change feature which allows for a change of cam speeds. (Refer to Page 5.0.2 in the Thermotron manual or drawing #19-G-43 in the Honeywell manual.) The change in cam rotation speed is directly proportional to the change in the cam rise time.

(Example) - The cam, using Chart No. 14950, has a standard rotation period of 24-hours. The time line divisions on the chart represent one hour time segments and the maximum rate of change is 2.35°F/Min.

The same cam can be made to have a maximum rate of change of 4.70°F/Min. by changing the cam drive gears to a 12-hour rotation. The cam now makes one revolution per 12 hours, and the time line divisions represent 1/2 hour time segments. In other words, doubling the number of rotations in a 24-hour period will double the rise time.

The following table has been prepared for your convenience.

ROTATION (HOURS)	MAXIMUM RATE OF CHANGE PER MIN. CHART #14950	MAXIMUM RATE OF CHANGE PER MIN. CHART #16381	PERIOD BETWEEN TIME LINES (1/24 ROTATION)
24	2.35	2.5	(60 Min.) 1 Hr.
12	4.70	5	(30 Min.) 1/2 Hr.
8	7.05	7.5	(20 Min.) 1/3 Hr.
6 ("AGREE")	9.4 ("AGREE")	10	(15 Min.) 1/4 Hr.
4	14.1	15	(10 Min.) 1/6 Hr.
3	18.8	20	(7.5 Min.) 1/8 Hr.

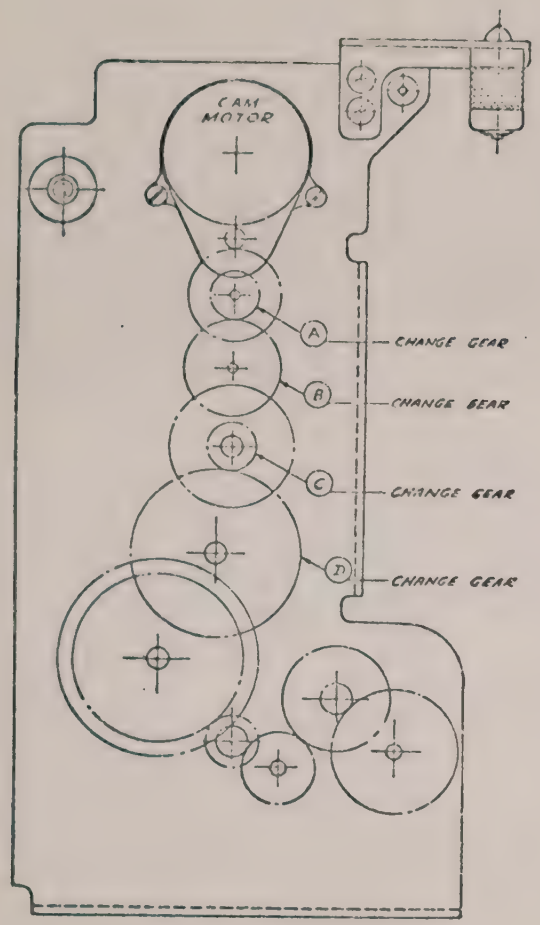
NOTE: Changing the cam speed only changes the transition time of the programmer. The actual maximum change rates of the chamber are dependent on engineering considerations of the heating and cooling capacities which may or may not be designed to change as fast as the rise of the cam.

In those cases, other than where a 24-hour cam rotation is used, it is often necessary to stop and start the cam during some stabilized period of the cycle to compensate for the time lost by increasing the cam speed. If you add all the time segments

on your program, you may have less than the time required for your test cycle. By stopping and starting the cam at various plateaus, you may extend the program cycle time. (This normally is accomplished with a timer or Tape Programmer.) Since the recorder chart motor does not stop and start with the cam but runs continuously, it records these "cam off" periods as a continuation of the level or plateau it is on. Together, the time on the cam and the time on the cam timer can be made to equal a 24-hour period.

Once the program is drawn on a chart, the chart can be glued to the blank cam. The cam can then be cut on a jigsaw, cutting the cam slightly larger then required. The cam can then be filed to smooth the edge and to form the cam to the required configuration.

A cam cutting service is also available from the Customer Service Department of Honeywell, Inc., Ft. Washington, Pa. Contact your nearest Honeywell Sales or Service Office for further information.



TEETH IN CHANGE GEAR				CAM (WITH 8 R.P.M. DRIVE MOTOR) ONE REV. FOR:	CAM (WITH ¼ R.P.M. DRIVE MOTOR) ONE REV. FOR:
A	B	C	D		
20	56	20	97	24 HOURS	6 DAYS
42	42	20	97	12 "	3 "
20	56	58	67	8 "	48 HOURS
56	20	20	97	6 "	36 "
42	42	58	67	4 "	24 "
42	42	67	58	3 "	18 "
20	56	97	20	2 "	12 "
56	20	67	58	1½ "	9 "
42	42	91	20	1 "	6 "
56	20	97	20	½ "	3 "

5.6.0

THE BROWN INSTRUMENT CO.
PHILADELPHIA, PA., U.S.A.

CHANGE GEAR DATA FOR CL.15 CIR. CHART POTENT. CRM TIME-PATTERN CONTROL

AUTOMATIC CONTROL SYSTEMS
THERMOTRON CORPORATION

OCTOBER 1971

THERMOTRON

USER'S MANUAL
THERMOPULSE MODEL 015002

THERMOPULSE® / 015002

UM-451002

INTRODUCTION

Thermopulse units are used to add proportioning-like action to simple ON-OFF type controllers. This produces a considerable improvement in control action.

The 015002 unit is designed expressly for Honeywell Class 152 and Class 452 temperature programmer/recorder/controller instrumentation. These units are also suited to applications involving most other types of electronic ON-OFF controllers.

FUNCTIONAL DESCRIPTION

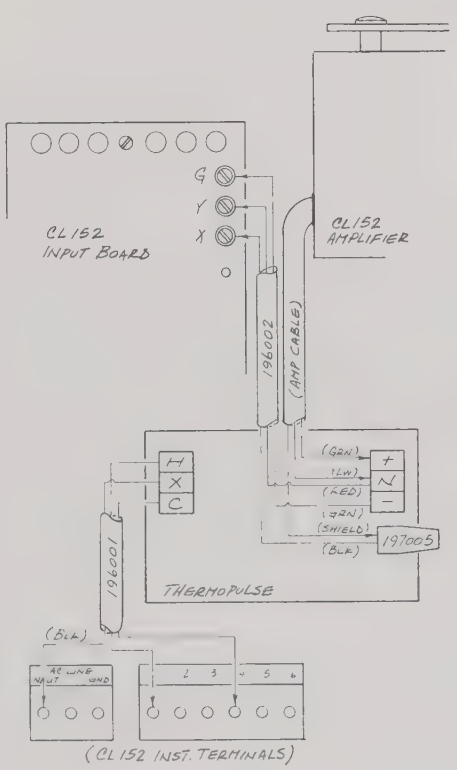
Thermopulse units improve the action of ON-OFF controllers by forcing the process to limit cycle above its natural period. Any process under ON-OFF control will limit cycle at its characteristic natural period. the natural period being the time for one complete cycle. Such cycling or oscillation causes the controlled variable to swing alternately above and below the set point in a sinusoidal manner. If the process is forced to limit cycle above its natural period (faster) the resultant oscillations will be reduced in amplitude. This means that the temperature deviates less from the set point, and thereby represents improved controller performance.

The Thermopulse unit introduces complimentary feedback at the controller which causes the controller to lead the actual process conditions. The feedback time constant is controlled at the Thermopulse. In actual operation, the natural period seen at the controller input is primarily established by this feedback time constant.

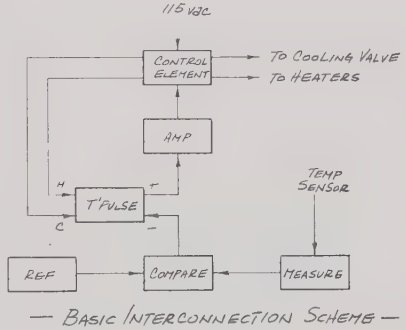
The Thermopulse is connected between the summing network and amplifier in the process controller. Its output compliments the output of the controller by algebraic addition with the deviation signal within the controller. In a temperature control application, when the controller switches a heater ON, the Thermopulse gradually decreases the deviation signals. Simultaneously, because the heater is ON, the actual deviation is also decreased somewhat. When the actual deviation signal plus the complimentary feedback produces an apparent deviation signal (amplifier input) equal to zero, the heater will be switched OFF. After the heater is switched OFF, its residual capacity continues to diminish the actual deviation while, at the same time, the feedback voltage from the Thermopulse slowly decays to zero.

THERMOTRON CORPORATION
937 South Washington Ave., Holland, Michigan 49423
(616) 392-1492/TWX (810) 292-6164

The device described herein is offered exclusively by Thermotron, which has no formal connection with Honeywell, Inc.



TYPICAL WIRING FOR HONEYWELL CL152
(TEMP. PROGRAMMER/RECORDER/CONTROLLER)

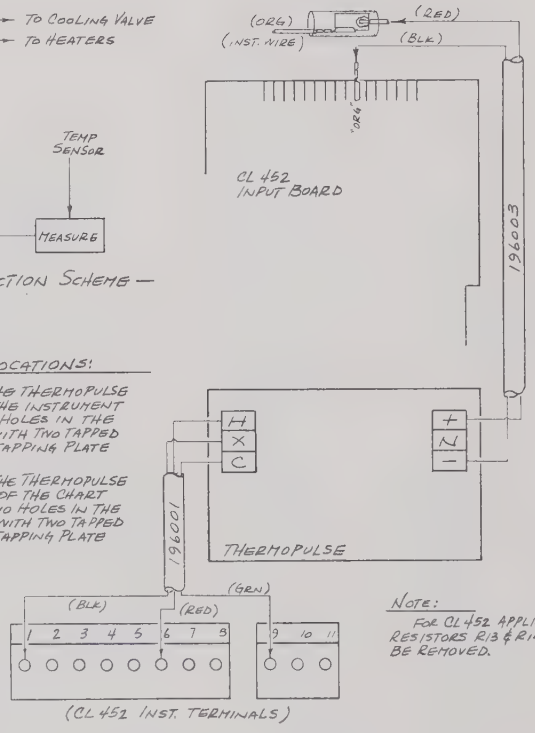


— BASIC INTERCONNECTION SCHEME —

THERMOPULSE MOUNTING LOCATIONS:

CL152 INSTRUMENTS: MOUNT THE THERMOPULSE UNDER THE LEFT END OF THE INSTRUMENT AMPLIFIER. THE BOTTOM TWO HOLES IN THE THERMOPULSE PCB ALLIGN WITH TWO TAPPED HOLES IN THE INSTRUMENT TAPPING PLATE AT THIS LOCATION.

CL452 INSTRUMENTS: MOUNT THE THERMOPULSE IMMEDIATELY TO THE RIGHT OF THE CHART DRIVE ASSEMBLY. THE TOP TWO HOLES IN THE THERMOPULSE PCB ALLIGN WITH TWO TAPPED HOLES IN THE INSTRUMENT TAPPING PLATE AT THIS LOCATION.



NOTE:
FOR CL452 APPLICATIONS RESISTORS R13 & R14 MUST BE REMOVED.

TYPICAL WIRING FOR HONEYWELL CL452
(TEMP. PROGRAMMER/RECORDER/CONTROLLER)

THERMOTRON
CORPORATION
HOLLAND, MICHIGAN 49423

NO	CHANGES	DATE	BY	CH'K'D
1	ADD 452 NOTE	20CT71	GN	
2	REV. WIRING: INPUTS	26OCT71	GN	

TOLERANCE —
SCALE —
MATERIAL AS NOTED
FINISH —
DRAWN BY ENARNER DATE 20CT71
CHECKED BY DATE
RELEASED BY DATE

DESCRIPTION
THERMOPULSE
INSTALLATION DATA
REF: 015002
470084

COOLING

The cooling equipment consists of two inter-dependent refrigeration systems arranged to operate in unison in conjunction with a cascade condenser. The refrigerant 13 system is the primary, and the refrigerant 502 system is the secondary cooling system. The cascade condenser is of concentric tube construction (tube within a tube). The inside tube is the condenser section of the R-13 system. The outer tube is the evaporator section of the R-502 system, therefore designated as a cascade condenser.

R-13 SYSTEM CYCLE

The R-13 compressor is a reciprocating piston direct-driven, semi-hermetic vapor pump, which compresses heat-laden, low pressure vapor to a high pressure. This high pressure vapor is piped to a water-cooled desuperheater which removes the heat of compression of the vapor. This vapor is piped to an oil separator which separates any entrained oil. (The oil is automatically returned to the crankcase of the compressor). This high pressure vapor is piped to the cascade condenser where it is condensed to a low temperature, high pressure liquid. This liquid is then piped to and through a full-flow filter-drier.

COOLING
Continued

It is metered through a thermostatic expansion valve and distributed into the chamber cooling coils (evaporators). This liquid R-13 expands and changes state to a low pressure vapor as it absorbs heat from the chamber. This low pressure, heat-laden vapor is then piped to the suction side of the R-13 compressor, thus completing the R-13 system cycle.

NOTE: An R-13 vapor expansion tank is tee'd into the low pressure piping. It serves as a storage and expansion tank. (Refer to Refrigeration Schematic).

R-502 System Cycle

The R-502 condensing unit is the secondary cooling system. Its function is to provide cooling for the cascade condenser. The R-502 compressor compresses heat-laden, low-pressure vapor to a high-pressure vapor. This is piped to a water-cooled condenser and changes state to a high-pressure liquid. This R-502 liquid is piped through a full-flow filter-drier and then through a sightglass (liquid indicator) and to a thermostatic expansion valve. This valve modulates to control the flow of liquid R-502 into the evaporator section of the cascade condenser by measuring and maintaining a predetermined super-heat of the R-502 vapor leaving the cascade. In this manner, the capacity requirements of the R-502 compressor are kept in balance with the system. The liquid R-502 expands and changes to vapor as it absorbs heat from the cascade condenser.

COOLING
(Continued)

This low pressure, heat-laden vapor is piped to the suction side of the R-502 compressor, thus completing the R-502 system cycle.

Both the R-13 and R-502 compressors are wired in parallel and will start when the cooling switch is turned ON. With a cooling demand from the instrument, the cooling control circuit is energized, and both compressors will start.

The cooling solenoid will be energized and opened. Cooling effect begins to lower the chamber temperature. When cooling demand is satisfied, the by-pass solenoid is energized (open) through the normally closed contact of the cooling control relay. The cooling solenoid is de-energized and closed. The compressor continues to operate in a by-pass condition (no cooling). With another cooling demand from the instrument, the sequence will repeat.

Cooling is controlled by the demand relay of the controlling instrument, and proportional control is achieved through the action of the heat and cool capacity control. This control must be properly set to produce best control and capacity rates throughout the total range of temperature.

R-13 CHARGE STANDBY PRESSURE

The R-13 system of the Thermotron cascade unit is charged by the "standby" method. The factory R-13 stand-by pressure is recorded on the equipment serial tag located on the inside of the electrical compartment door. This will allow a comparison to the present R-13 stand-by pressure in the system.

To read the R-13 standby pressure properly, two requirements must be met. First, the entire R-13 system (including the cascade) must be at or near ambient temperature. (70°F. or 21°C.) Secondly, the R-13 system must be equalized. After the system has equalized, the standby pressure may be read on the R-13 discharge pressure gauge. If the gauge reading is approximately that of the recorded stand-by pressure, the system will meet the design requirements.

R-502 CHARGE

A sightglass is used to check the charge in the R-502 system. To check the charge, watch the sightglass for bubbles during the pulldown of the system. There should be no bubbles during the pulldown. (The system should run a minimum of two minutes before checking for bubbles).

OPERATING PRESSURES

A review of the enclosed pressure/temperature chart will serve as a guide in the operation and service of the Thermotron R-13, R-502 cascade unit. This table will enable the operator to determine the proper operating pressures for the temperature given. There is one point to be kept in mind, however, when using this table.

There is a temperature difference between the evaporator temperature and the recorded chamber temperature. In most cases this difference is approximately 15°F. That is, the evaporator is working approximately 15°F. colder than the temperature that is being recorded in the chamber.

To demonstrate this difference, a chamber that is controlling at -50°F. would show pressure readings on the gauges that would indicate the temperature should be -65°F. The 15°F. difference is the difference in the two operating temperatures and is characteristic of this type of equipment.

R-502 DISCHARGE PRESSURE:

The pressure of the R-502 system is dependent on the temperature of the water passing through the water-cooled condenser.

The discharge pressure is factory-adjusted to read approximately 200 P.S.I. (The R-502 discharge pressure may be set by adjusting the water flow economizer valve).

THERMOTRON CORPORATION

937 S. Washington Avenue Phone: (616) 392-1492

Holland, Michigan

SATURATION PRESSURE--TEMPERATURE TABLE

Temperature	Gage Pressure (P.S.I.G.)			
°F.	R-13	R-502	R-12	R-22
-110	2.1		27.9*	26.6*
-105			27.5*	25.9*
-100	7.5		27.0*	25.6*
- 98			26.7*	
- 96			26.5*	
- 95	10.7		26.4*	24.0*
- 94			26.2*	
- 92			26.0*	
- 90	14.2		25.7*	22.9*
- 88			25.4*	
- 86			25.1*	
- 85	18.1		24.9*	21.6*
- 84			24.7*	
- 82			24.4*	
- 80	22.3	17.1*	24.0*	20.1*
- 78		16.3*	23.6*	19.5*
- 76		15.4*	23.2*	18.8*
- 75	27.9	15.0*	23.0*	18.5*
- 74		14.6*	22.8*	18.1*
- 72		13.6*	22.3*	17.3*
- 70	32.0	12.6*	21.8*	16.5*
- 68		11.6*	21.3*	15.7*
- 66		10.5*	20.8*	14.8*
- 65	37.5	9.9*	20.5*	13.4*
- 64		9.3*	20.2*	13.9*
- 62		8.2*	19.6*	12.9*
- 60	43.5	6.9*	19.0*	11.9*
- 58		5.7*	18.3*	10.8*
- 56		4.3*	17.7*	9.7*
- 55	50.0	3.6*	17.3*	9.1*
- 54		2.9*	17.0*	8.5*
- 52		1.4*	16.2*	7.3*
- 50	57.0	.0	15.4*	6.0*
- 48		.8	14.6*	4.7*
- 46		1.6	13.7*	3.3*
- 45	64.6	2.0	13.3*	2.6*
- 44		2.5	12.9*	1.8*
- 42		3.4	11.9*	0.3*
- 40	72.7	4.3	11.0*	0.6*
- 38		5.2	10.0*	1.4
- 36		6.2	8.9*	2.3
- 35	81.5	6.7	8.4*	2.6
- 34		7.2	7.8*	3.1
- 32		8.3	6.7*	4.0
- 30	90.9	9.4	5.5*	5.0

* Inches of Mercury below one atmosphere.

THERMOTRON CORPORATION

SATURATION PRESSURE--TEMPERATURE TABLE

Temperature	Gage Pressure (P.S.I.G.)			
°F.	R-13	R-502	R-12	R-22
-30	90.9	9.4	5.5*	5.0
-28	94.9	10.5	4.2*	6.0
-26	99.0	11.7	3.0*	7.0
-25			2.3*	
-24	103.0	12.9	1.6*	8.0
-22	107.3	14.2	0.3*	9.1
-20	111.7	15.5	0.6	10.3
-18	116.2	16.9	1.3	11.5
-16	120.8	18.3	2.0	12.7
-15			2.4	
-14	125.7	19.7	2.8	13.9
-12	130.5	20.2	3.6	15.2
-10	135.4	22.8	4.5	16.5
- 8	140.5	24.3	5.4	18.0
- 6	145.7	26.0	6.2	19.4
- 5			6.7	
- 4	151.1	27.7	7.2	20.9
- 2	156.5	29.4	8.1	22.5
0	162.2	31.2	9.1	24.0
2	167.9	33.1	10.2	25.7
4	173.7	35.0	11.2	27.4
5			11.8	28.3
6	179.8	37.0	12.3	29.2
8	185.9	39.0	13.5	31.0
10	192.2	41.0	14.6	32.9
12	198.6	43.2	15.8	34.9
14	205.2	45.4	17.1	36.9
15			17.7	
16	211.9	47.7	18.4	40.0
18	218.8	50.0	19.7	41.0
20	225.8	52.4	21.0	43.3
22	233.0	54.9	22.4	45.5
24	240.3	57.4	23.9	47.8
25			24.6	
26	274.8	60.0	25.4	50.2
28	255.5	62.7	26.9	42.7
30	263.3	65.4	28.4	55.2
32	271.3	68.2	30.0	57.8
34	279.5	71.1	31.7	60.5
35			32.6	
36	287.8	74.0	33.4	63.2
38	296.3	77.1	35.2	66.1
40	305.0	80.2	37.0	69.0
42		83.3	39.0	72.0
44		86.6	40.7	75.0
45	327.5		41.7	

* Inches of Mercury below one atmosphere.

THERMOTRON CORPORATION

937 S. Washington Avenue Phone: (616) 392-1492

Holland, Michigan

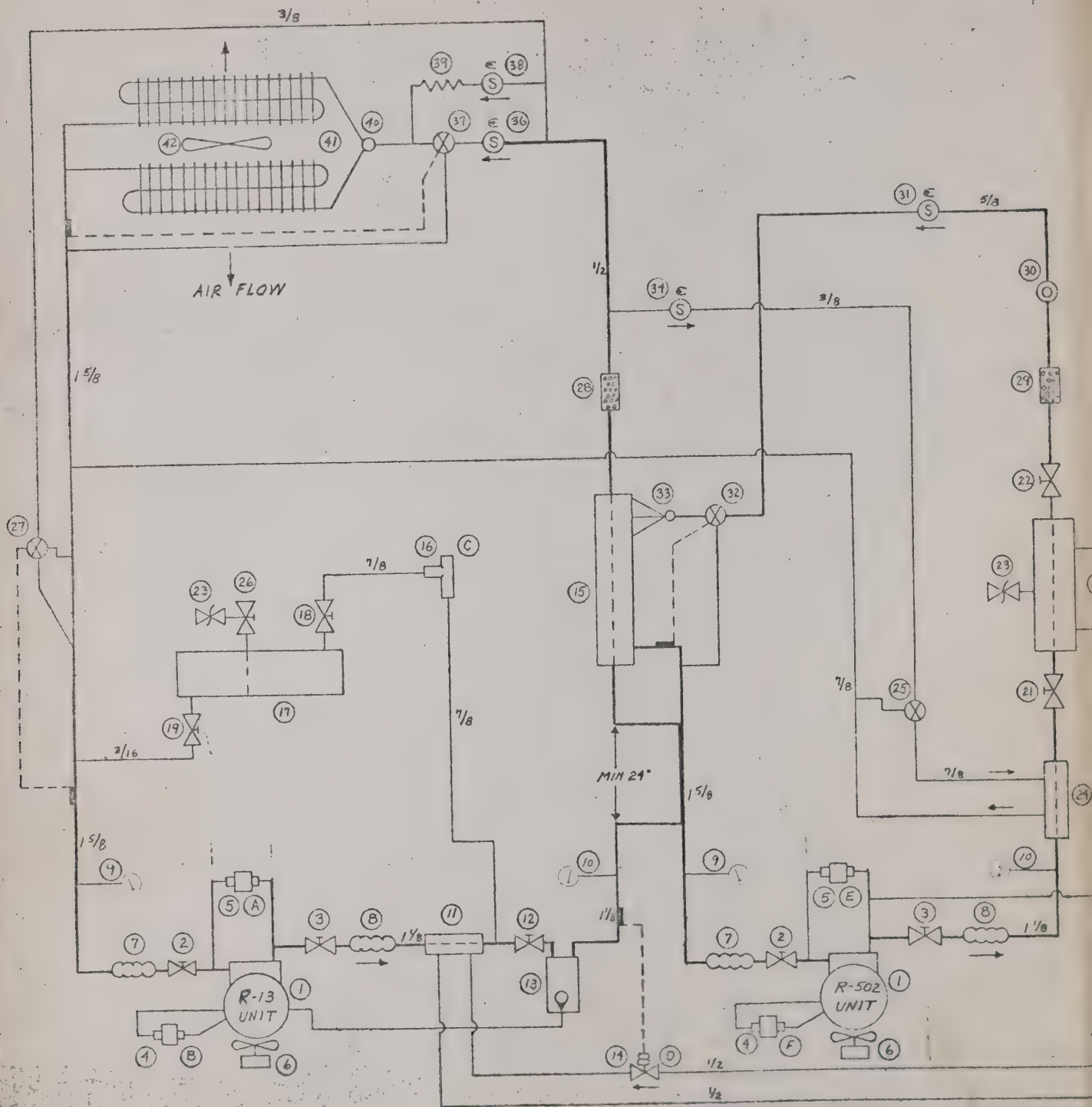
SATURATION PRESSURE--TEMPERATURE TABLE

Temperature	Gage Pressure (P.S.I.G.)			
°F.	R-13	R-502	R-12	R-22
45	327.5		41.7	
46		90.0	42.6	78.1
48		93.4	44.6	81.4
50	351.2	96.9	46.7	84.7
52		100.5	48.8	88.1
54		104.1	50.9	91.5
55	376.1		52.0	
56		107.9	53.1	95.1
58		111.7	55.4	98.8
60	402.4	115.6	57.7	102.5
62		119.6	60.1	106.3
64		123.7	62.5	110.2
65	429.8		63.8	
66		127.9	65.0	114.2
68		132.2	67.6	118.3
70	458.8	136.6	70.2	122.5
72		141.1	72.9	126.8
74		145.6	75.6	131.2
75	489.0		77.0	
76		150.3	78.4	135.7
78		155.1	81.2	140.3
80	521.0	159.9	84.2	145.0
82		164.9	87.2	149.8
84		170.0	90.2	154.7
85			91.7	
86		175.1	93.3	159.8
88		180.4	96.5	164.9
90		185.8	99.8	170.1
92		191.3	103.1	175.4
94		196.9	106.5	180.9
95			108.2	
96		202.6	110.0	186.5
98		208.4	113.5	192.1
100		214.4	117.2	197.9
102		220.4	120.9	203.8
104		226.6	124.6	209.9
105			126.5	
106		232.9	128.5	216.0
108		239.3	132.4	222.3
110		245.8	136.4	228.7
112		252.5	140.5	235.2
114		259.2	144.7	241.9
115			146.8	
116		266.1	148.9	248.7
118		273.1	153.2	255.6
120		280.3	157.6	262.6

THERMOTRON CORPORATION

SATURATION PRESSURE--TEMPERATURE TABLE

Temperature	Gage Pressure (P.S.I.G.)			
°F.	R-13	R-502	R-12	R-22
120		280.3	157.6	262.6
122		287.6	162.1	
124		295.0	166.7	
125			169.1	280.7
126		302.5	171.4	
128		310.2	176.2	
130		318.0	181.0	299.7
132		326.0	185.9	
134		334.1	191.0	
135			193.5	319.6
136		342.3	196.1	
138		350.7	201.3	
140		359.2	206.6	340.3
142		367.8	212.0	
144		376.7	217.5	
145			220.3	362.0
146		385.6	223.1	
148		394.7	228.8	
150		404.0	234.6	384.6
152		413.4	240.5	
154		423.0	246.5	
155			249.5	406.3
156		432.7	252.6	
158		442.6	258.8	
160		452.6	265.1	443.3



SYM	DATE	CHANGE

DR
1/4

No.	PART NUMBER	DESCRIPTION	P.O. NUMBER	QTY
1	[illegible]	MOTOR COMPRESSORS	[illegible]	2
2	WITH UNIT	SUCTION SERVICE VALVES	"	2
3	[illegible]	DISCHARGE SERVICE VALVES	"	2
4	PENN PHSN6CR	OIL PRESSURE SWITCH	STOCK	2
5	PENN P70NAI	HI-LOW PRESSURE SWITCH	"	2
6	[illegible]	COMPRESSOR COOLING FANS 440V	[illegible]	2
7	6A6AFX	SUCTION VIBRATION ELIMINATORS	STOCK	2
8	[illegible]	DISCHARGE VIBRATION ELIMINATORS	"	2
9	[illegible]	LOW PRESSURE GAUGE	"	2
10	[illegible]	HIGH PRESSURE GAUGE	"	2
11	2H09	R-13 DISCHARGE DESUPERHEATER	SHOP	1
12	F6E109	R-13 PUMPDOWN VALVE	STOCK	1
13	ACOR S-55½	R-13 OIL SEPARATOR	"	1
14	PENN V7DM3	R-13 DESUPERHEAT WATER REGULATOR	"	1
15	¾ x ¾ KSC	CASCADE CONDENSOR	SHOP	8
16	CC 70200 192	R-13 HIGH PRESSURE DUMP VALVE	STOCK	1
17	48122	R-13 VAPOR TANK	17410	1
18	ROTOLOCK ⅞	R-13 VAPOR TANK INLET VALVE	"	1
19	ROTOLOCK ⅝	R-13 VAPOR TANK OUTLET VALVE	"	1
20	[illegible]	R-502 CONDENSER	[illegible]	1
21	ROTOLOCK 1⅛	R-502 CONDENSER INLET VALVE	"	1
22	ROTOLOCK ⅝	R-502 CONDENSER OUTLET VALVE	"	1
23	[illegible]	RELIEF VALVES	STOCK	2
24	R2801	R-13 BYPASS HEAT EXCHANGER	16946	1
25	CPFE-5-⅜	R-13 BYPASS EXPANSION VALVE	STOCK	1
26	MBA 13656	R-13 PURGE VALVE	"	1
27	CRE-4-C	R-13 INJECTION EXPANSION VALVE	"	1
28	ADK 414	R-13 FILTER DRIER	"	1
29	ADK 415	R-502 FILTER DRIER	"	1
30	SA155	R-502 LIQUID INDICATOR	STOCK	1
31	[illegible]	R-502 LIQUID SOLENOID	"	1
32	[illegible]	R-502 EXPANSION VALVE	"	1
33	ALCO 74-8	R-502 DISTRIBUTER	"	1
34	220R353	R-13 BYPASS SOLENOID	"	1
35	V46AE-1	R-502 WATER REGULATING VALVE	STOCK	1
36	220R3-3	R-13 LARGE LIQUID SOLENOID	"	1
37	CEE-3-6P	R-13 EXPANSION VALVE	"	1
38	AEFI	R-13 SMALL LIQUID SOLENOID	"	1
39	3/16 X 3'	FLOW CONTROL	SHOP	1
40	ALCO [illegible]	R-13 DISTRIBUTER	STOCK	1
41	[illegible]	FAN COILS	[illegible]	2
42	[illegible]	FAN BLADE	- REF -	—

(A) R-13 LOW OPEN 5" HIGH OPEN 275 PSI MANUAL RESET
(B) R-13 OIL PRESET NONADJUSTABLE MANUAL RESET
(C) R-13 HIGH PRESSURE RELIEF SET AT 235 PSI
(D) R-13 DESUPERHEAT WATER SET AT 90°
(E) R-502 LOW OPEN 0 HIGH OPEN 275 PSI MANUAL RESET
(F) R-502 OIL PRESET NONADJUSTABLE MANUAL RESET
(G) R-502 WATER REGULATOR SET AT 200 PSI

POWER SUPPLY 440/3/60

SUPPLY
1¼ NPT

TELEDYNE SYSTEMS

[illegible]	MATERIAL	THERMOTRON CORP. HOLLAND, MICHIGAN U.S.A.
[illegible]	[illegible]	DRAWING NO.

HEATING

The heating of the chamber is achieved with three circular type resistance heaters, rated at 4.5 K.W., producing a total of 13,500 watts. The heaters are located in the conditioned air stream above the circulator baffle to provide balanced heating distribution within the test space.

Heating is controlled by the demand relay of the controlling instrument and proportional control is achieved by the action of the heating input unit. Heating capacity is achieved with the action of the heating delay timer. (See Electrical Schematic TM1). This adjustable time delay must be properly set to produce best control and capacity rates throughout the total range of temperature.

HIGH HEAT LIMITS

The chamber high heat limit is the prime protective device in the heating system on this chamber. It is, therefore, extremely important that it is properly adjusted and tested.

Heat Limit Adjustment:

The chamber heat limit is factory adjusted to open when the chamber temperature is approximately +350°F., the highest operating temperature of the chamber.

The chamber heat limit is a manual reset type. Once the setting of the heat limit has been exceeded, the reset button must be manually depressed.

Periodic Checks:

It is a good practice to check the heat limit when the opportunity presents itself. For example, if you have been working on the instruments, set the setpoint of the controller above the setting of the heat limit, and allow the chamber temperature to rise. The heat limit should open. (Push the manual reset button.) This check takes only a few minutes.

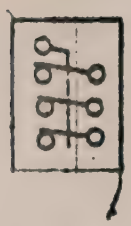
It is advisable to have the chamber empty when performing this test so no accidental damage occurs to any item in the chamber.

Heat Limit:

The high heat limit is installed to protect the chamber from exceeding its limits. It is not intended for customer product protection.

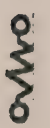
ELECTRICAL SCHEMATIC

LEGEND



Disconnect Switch

Fuse



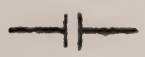
Heater

Pilot Light

Chamber Light

Energizing Coil
(Contactor, Timer, Relay, etc.)

Motor



Normally Open Contact

Normally Closed Contact

Thermal Actuated Switch
(Heat & Cooling Limits, etc.)

Instrument Controller

Pressure Actuated Switch

Compressor Control Relay

Compressor Fuses

Compressor Fan

Ref. Solenoid

LINE NUMBERS

There are two sets of line numbers on the Electrical Schematic.

The numbers to the left are used when referring to the components on a particular line. For example, you might refer to a contactor located on Line 9. By looking down the left column to Line 9, you will locate the line the contactor is located on.

The numbers to the right of the ground line (X2) are used to locate the contacts of the energizing coil on that line. For example, a line that had a number 18 after it would indicate the energizing coil of that component was closing a contact that was located on Line 18 of the left column. Going across Line 18 to the right, you would find the labeled contact that corresponded to the energizing coil. Several numbers after a line indicate there are several contact locations on the schematic.

Variations of numbers are as follows:

X - The contact is located on Line X.

<u>X</u> - The contact is located on Line X and is wired normally closed.

X TC - The contact on Line X is timed to close.

X TO - The contact on Line X is timed to open.

P - The contact is located in the power section.

INSTANT - The contact is on a timer but makes instantly when energized.

A/C - The contact is an auxiliary contact or a contactor.

COMPONENT LOCATION

To assist you in physically locating the component parts of this equipment, the electrical parts list has been coded. The code is listed under the column headed location (LOC). The column symbols are as follows:

P - The component parts are mounted on the electrical panel.

M - The component parts are mounted on the machinery section.

CO - The component parts are mounted in the electrical console.

CH - The component parts are mounted on the chamber.

EC - The component parts are mounted in the electrical compartment.

RELAYS

Reference Electrical Schematic No. E-5670-1-X.

B Blower control relay.
Coil on line #16.
Contact in main power.
Function - To apply power to quiet package blower motor.

C Circulator motor contactor.
Coil on line #4.
Contact in main power.
Function - To apply power to circulation motor.

CLR Cam latching relay.
Coil on line #24.
Contact on line #27..
Function - To apply power to the instrument cam motor for automatic control of the program cam for starting and stopping.

CR1 Cooling control relay.
Coil on line #9.
Contact on line #11 and 25.
Function - Line #11 to apply power to TR and TM3 coils.
Function - Line #25 to apply power to R-13 small liquid solenoid.

H1 Heat 1 contactor.
Coil on line #6. Contacts in main power.
Function - Low heat for control provides for redcued wattage from the heating circuit.

H2 Heat 2 contactor.
Coil on line #8. Contacts in main power.
Function - High heat for fast temperature change. Provides for maximum wattage from the heating circuit.

RELAYS

MH Master heat contactors.

Coil on line #5. Contacts in main power and line #6.

Function - Heater safety contactors to de-energize with heat limit (HLS-1, line #5). Energized whenever power is applied to the chamber control circuits and the chamber temperature does not exceed the limit of the safety devices.

MR Malfunction relay - (One second delay on dropout.)

Coil on line #15.

Contact on lines #13, 15 and 16.

Function - A holding relay that holds all of the refrigeration safety control in the circuit (Line #15). Upon an "out of tolerance" condition on any of the refrigeration safety switches, the MR coil is de-enrgized and the complete circuit is opened. The MR relay is reset by energizing the reset pushbutton (Line #14).

SLR Shaker latching relay.

Coil on line #23.

Contact on line #29.

Function - To apply power to shaker control.

TM1 Delay timer #1 - (High heat delay timer.)

Coil on line #7.

Contact on line #8.

Function - To delay energizing contactor H2.

TM2 Delay timer#2 - (Compressor timeout timer.)

Coil on line #10.

Contactor on line #17.

Function - To keep compressor running for approximately 60 to 90 seconds after last cooling pulse.

TM3 Delay timer #3 - (Large R-13 cooling solenoid delay.)

Coil on line #12.

Contact on line #22 and 23.

Function - To delay energizing the large R-13 solenoid for 1 to 10 seconds.

RELAYS

TR Timed relay - (One second delay on dropout.)

Coil on line #11.

Contact on line #10 and 19.

Function - To eliminate false malfunction tripping caused by electrical transients.

13 R-13 compressor contactor.

Coil on line #20.

Contacts in main power.

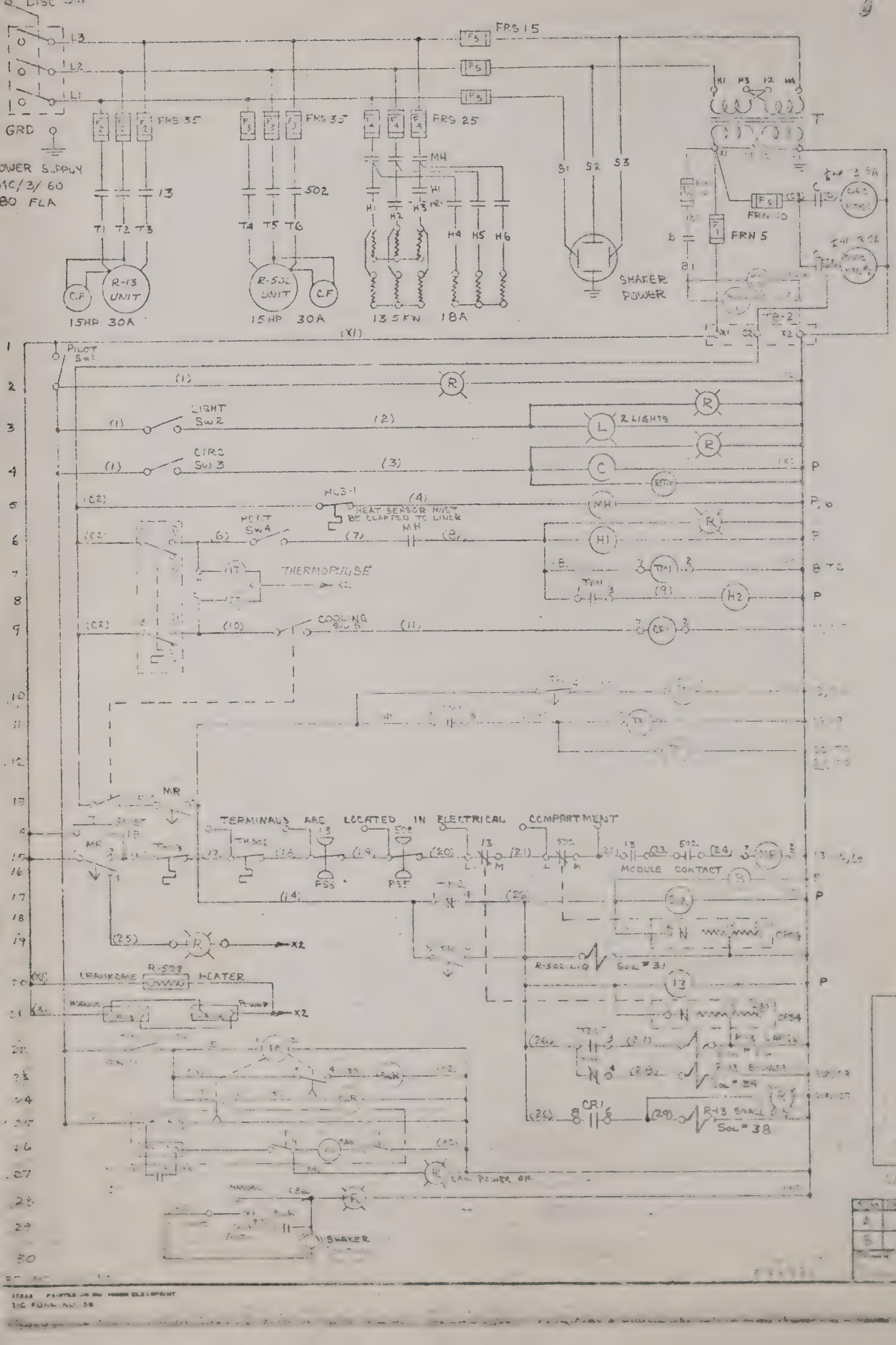
Function - To energize R-13 compressor.

502 R-502 compressor contactor.

Coil on line #17.

Contacts in main power.

Function - To energize R-502 compressor.


DISC SW
L3
L2
L1
GRD
POWER S.PPLY
MC/3/60
80 FLA
FRS 15
FRS 35
FRS 35
FRS 25
MH
13
502
T1 T2 T3
T4 T5 T6
H1 H2 H3
H4 H5 H6
R-13 UNIT
R-502 UNIT
C.F
15HP 30A
15HP 30A
13.5KW 18A
S1 S2 S3
SHAKER POWER
T
FRN 10
FRN 5
TB-2
(X1)
PILOT SW1
LIGHT SW2
CIRC SW3
HEAT SW4
HGS-1
HEAT SENSOR MUST BE CLAMPED TO LINER
THERMOPULSE
COOLING SW5
2 LIGHTS
TERMINALS ARE LOCATED IN ELECTRICAL COMPARTMENT
MR
PSS
PSF
MODULE CONTACT
R-502 LIQ SOL #31
R-13 SUCT SOL #38
CRANKCASE HEATER
R-502
CAN POWER ON
SHAKER
DATE

DESCRIPTION	MFG	P.D. Number	QTY
DISCONNECT SWITCH 100A 480V	[illegible] IE	[illegible]	1
[illegible] TERMINALS	SQ. D	"	2
CONTROL CKT. TERMINALS			1
[illegible]	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	2
[illegible]	[illegible]	[illegible]	3
F.U.S & XFORMER FUSE	"	"	3
[illegible]	"	"	1
BLOCK [illegible] 3P 600V	[illegible]	[illegible]	2
[illegible]	[illegible]	[illegible]	2
[illegible] 1P 250V	[illegible]	[illegible]	2
POWER CONTACT 4P 30A	[illegible]	"	2
COMPRESSOR MOTOR	COPELAND	[illegible]	—
[illegible] CONTACTOR 4P 80A	[illegible]	[illegible]	1
[illegible] 2P 240V	[illegible]	[illegible]	1
[illegible] 4.5KW @ 440V	[illegible]	[illegible]	2
[illegible]	[illegible]	[illegible]	—
CONTACTOR	[illegible]	[illegible]	1
POWER RECEPTACLE	[illegible]	"	1
[illegible] FOR SHUTTLE RECEPTACLE	[illegible]	"	1
[illegible]	[illegible]	"	2
[illegible]	[illegible]	"	2
HEAT LIMIT (MANUAL RESET)	[illegible]	"	1
[illegible] TIME DELAY	[illegible]	[illegible]	1
[illegible]	PEC	[illegible]	1
[illegible]	CURTIS	"	1
[illegible] LIGHT	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	1
[illegible]

PROTECTIVE OR SAFETY DEVICES

The following are the protective or safety devices used in the refrigeration and electrical circuits (besides the branch circuit protection). Refer to electrical and refrigeration schematics.

(2) Relief Valves:

One is located in the high pressure piping of the R-13 system, and one is located in the high pressure piping of the R-502 system to protect the systems against excessive pressure. The valves are factory-designed to relieve at 320 P.S.I.

(2) Dual Function Hi-Low Pressure Switches:

One in each refrigeration system - R-13 primary cooling system and the R-502 secondary cooling system. The Hi-side of this switch is piped to sense the pressure of the discharge side of the refrigeration compressor, set to interrupt the control circuit of the compressor at abnormal pressure. The Low-side of this switch is piped to sense the pressure of the suction side of the refrigeration compressor at abnormal pressure. The switches are manually reset. (Factory set and adjustable). See refrigeration schematic for factory settings.

PROTECTIVE OR SAFETY DEVICES
(Continued)

(1) Hi-Pressure Regulating Valve: (Refrigeration Schematic) The function of this valve is to prevent the high pressure of the R-13 system from rising above 250 lbs. When the pressure exceeds this value, the valve opens and relieves this pressure to the R-13 vapor tank. The R-13 is returned to the system through flow control tubes, to control the rate of return of R-13 vapor to the suction side of the system.

(2) (Penn) Oil Pressure Differential Switches: (Refrigeration Schematic) One each in the R-502 and R-13 systems, located to sense the oil pressure and suction pressure of the compressor. This switch is factory-adjusted to open the electrical control circuit of the compressor at 5 P.S.I. difference, to protect the compressor against oil pressure failure.
This switch requires a manual reset.

CAUTION: Do not reset more than twice in succession, until the cause has been determined and corrected.

(1) Interlock: (Electrical Schematic) (C) Circulator starter to heat control circuit to protect the heaters. The heating control circuit cannot be energized until the circulator starter is energized.

PROTECTIVE OR SAFETY DEVICES

(Continued)

(1) Hi-Heat Limit (Electrical Schematic, HLS-1) is wired in series with the heating control circuit to open the circuit to protect the chamber from exceeding designed temperature limits. This control is set to open when the chamber temperature exceeds 350°F. (Manual reset.)

(2) Compressor Discharge Gas Temperature Limit (Electrical Schematic) One each in the R-13 and R-502 control circuit. Factory-adjusted to interrupt the control circuit if the discharge gas temperature exceeds 240°F. This will occur only at abnormal conditions. (Adjustable) (Manually Reset)

(2) Inherent Overload Protections (Electrical Schematic) One in each refrigeration motor compressor. These are factory-designed to open the motor circuit within safe limits. (Non-Adjustable) (Automatic Reset)

(1) Compressor Crankcase Heater (Electrical Schematic) located in the bottom of the compressor crankcase (in the R-502 compressor) to prevent any liquid refrigerant from collecting in the oil. Refer to Electrical Schematic and note the 110 volt circuit to the crankcase heater is not in the pilot circuit.

PROTECTIVE OR SAFETY DEVICES
(Continued)

(1) Malfunction Alarm Relay Located and wired in series with all safety devices in the compressors control circuit. (Electrical Schematic). If the control circuit is interrupted from any cause, MR Relay will de-energize and the alarm light will indicate a malfunction.

If this occurs, the cause must be determined and corrected before manually resetting MR Relay.

(1) Master Heater Contactor: (Refer to Electrical Schematic) This contactor is wired in series with the Heat Control Contactors. Its function is to provide more positive protection against over-temperature of the chamber.

NOTE: This contactor does not cycle with Heat Demand as the heat contactors.

It will cycle ON and OFF only with the High Temperature Limit Thermostat, thereby providing protection against burned closed contacts.

A Guard is provided for the circulator fan.

All Refrigerants used are non-toxic.

All Electrical Circuits are separately fused.

All Control Switches have indicator lights.

All Machinery is enclosed.

OPERATING INSTRUCTIONS

REFRIGERATION RESET

CAUTION

EQUIPMENT MAY BE
DAMAGED AND WARRANTY
VOID BY IMPROPER
RESETTING. REFER TO
EQUIPMENT MANUAL
FOR OPERATING INSTRUCTIONS.

The refrigeration reset circuit consists of a magnetically latched malfunction relay and its associated safety devices. These safety devices are wired in series with the malfunction relay so the interruption of any single safety device will de-energize the malfunction relay which, in turn, disengages the control power to the compressor contactors.

If repeated tripping (more than twice) is experienced, the source of the tripping must be located. Continuous resetting to complete a test or portion of a program cycle could cause damage to the refrigeration system.

Circuit Description

The refrigeration reset pushbutton (PB) is a momentary contact switch that energizes the malfunction relay (MR) through the refrigeration safety circuit. Once initially reset, the malfunction relay (MR) is magnetically latched until one of the refrigeration safety devices or a main power interruption opens the circuit.

OPERATING INSTRUCTIONS
(Continued)

In the event a malfunction should occur, the malfunction light on the electrical panel door will be energized, indicating a main power interruption or a malfunction of one of the refrigeration protective devices. If the light is energized, push the reset pushbutton.

In the event the system does not restart immediately, the R-13 and R-502 inherent overload protection and the R-13, R-502 discharge temperature limits could be suspect. The discharge temperature limits require approximately three minutes before manually resetting. The inherent overload protection requires approximately 15 minutes to automatically reset. If the R-502 discharge temperature limit is open, most likely causes for its opening would have been an insufficient refrigeration charge. To check the R-502 charge, look for bubbles in the sight glass on the R-502 system.

If the R-13 discharge temperature limit is open, check to see if the R-13 injection valve is feeding properly. If the valve appears to be okay, check the R-13 by-pass pressure.* It should be above 5# pressure. If the system continues to open on the R-13 discharge temperature limit, contact a factory representative for further information. If the system restarts after approximately 15 minutes, the inherent overload protection should be checked.

*This is the back pressure read on the R-13 suction gauge when the system is in by-pass operation.

OPERATING INSTRUCTIONS
(Continued)

To check the R-13, R-502 inherent overload protectors, measure the three phase current of each of the R-13 and R-502 compressors. Excessive current on any one leg would indicate a problem in the compressors and further determination will have to be made. (Contact a factory representative for assistance).

If after an approximate 15 minute delay the system does not restart, the R-13, R-502 oil differential switch and the R-13, R-502 high-low pressure switch should be checked. To check the R-13 oil differential switch, manually reset the oil differential switch. Push the refrigeration reset pushbutton. If the refrigeration system restarts, this switch was open, and the cause for its opening must be determined. Check the oil level of the compressors. If the oil level is sufficient, contact a factory representative for assistance. To check the R-502 oil differential switch, the same procedure should be followed.

To check the R-13 high-low pressure switch, push the reset pushbutton and push the refrigeration pushbutton. If the system restarts, this device was open, and the cause for its opening must be determined. By watching the high and low pressure gauges during operation, it can be determined which of these do exceed the limits. If it appears that the R-13 low pressure is opening, determine the R-13 standby pressure. If this pressure is approximately the same as stated on the equipment serial tag, the charge can be assumed to be okay.

OPERATING INSTRUCTIONS
(Continued)

A check should also be made to see if the circulator motor is running. If both of these checks are okay, a factory representative should be contacted for further information. If the pressure readings indicate the R-13 high pressure is opening, check the R-502 sight glass for bubbles (indicating a low charge). If the R-502 charge appears to be okay, again a factory representative should be contacted.

To check the R-502 high-low pressure switch, push the reset pushbutton, and the refrigeration reset pushbutton. If the system restarts, this device was open, and it must be determined whether the high or low pressure side of the device caused it to open. If the high pressure readings exceed the standard 200 PSIG, check the refrigeration system water supply. If the low pressure readings are below 0 PSIG, check the R-502 sight glass for a gas shortage.

OPERATING INSTRUCTIONS

EXTENDED POWER OUTAGE

There is always some liquid refrigerant present in the R-502 system. This refrigerant will condense at the coolest spot in the system. After an extended shutdown the compressor will reach the ambient temperature. Because it is closer to the floor and in more drafts, it will become the coolest spot in the system. The refrigerant will condense in the compressor crankcase, and because it is miscible it will go into solution with the oil.

If the compressor is started in this condition, the refrigerant boils violently and carries the oil with it through the compressor. This causes an oil shortage in the compressor crankcase, which will shorten bearing life and may cause the oil differential switch to open.

To prevent the R-502 refrigerant from condensing in the compressor crankcase, a crankcase heater is installed in the compressor. As long as the main power is on, the heater prevents the refrigerant from condensing in the crankcase. If the main power is interrupted for a sufficient time, the refrigerant will again condense in the crankcase. It is, therefore, necessary after extended main power interruptions to allow a sufficient warm up time before operating the compressor.

OPERATING INSTRUCTIONS

EXTENDED POWER OUTAGE: Continued

The easiest way to determine this time is to feel the bottom of the compressor crankcase. If the crankcase is warm, there will be no condensed liquid. If it is at ambient or cooler the crankcase heater must be given time to warm the crankcase and boil off any refrigerant.

EXTREME TEMPERATURE WARNING:

This equipment is designed to operate at extreme high and low temperatures. Care should be taken to prevent exposure (opening the door or putting a hand through a port) at temperatures other than near ambient.

CONTROL SWITCHES

THE PILOT SWITCH is wired in series with all major control function switches and can be considered a master control switch. In the OFF position, the complete chamber will be shut down (except the crankcase heater and malfunction relay), interrupting all control and pilot circuits, regardless, if any other control switches are left in the ON position.

THE CIRCULATOR SWITCH controls the operation of the air circulator. This switch must be ON to complete the heating and cooling control circuits.

THE HEAT SWITCH energizes the heating contactor through the instrument.

THE COOL SWITCH energizes the cooling control relay, and completes the circuit to the timers and cooling control circuit.

THE SHAKER SWITCH directly energizes the shaker control circuit in the manual position. The shaker is controlled through the latching relay controlled by the shaker program time clock in the automatic position. (See PTS-23000 for detailed instructions on the Paragon Time Clock.)

OPERATING INSTRUCTIONS

These operating instructions will assist the operator in placing the chamber in operation. A thorough study of the schematics and operating instructions for each control component should be made to become proficient in operating this chamber.

ONE SET POINT TEMPERATURE OPERATION:

One set point temperature operation is described as that operation in which one temperature is maintained for an extended period. The set point may be any temperature in the range of the chamber. The programming instrument uses a disc cam as a means of setting the temperature. A sample cam pattern may be found in the instrument instruction manual. One should be made for the instrument to be used. The following steps can then be followed to place the chamber in operation:

1. Turn the instrument power switches ON. The cam switch should be in the OFF position.
2. Install a new chart and ink the pen.
3. Place the cam follower arm at the desired temperature on the cam disc.
4. Turn the pilot switch ON.
5. Turn the circulator switch ON.
6. For temperature settings below ambient, turn the cooling switch ON.
7. For temperature settings above ambient, turn the heating switch ON.
8. Select the desired shaker operation mode.

OPERATING INSTRUCTIONS

PROGRAMMED TEMPERATURE OPERATION:

Programmed temperature operation is described as that operation in which the environment temperature follows a succession of predetermined temperatures as outlined on the programming cam. These temperatures may cover the entire de ned temperature range of the chamber in one programmed operation. A programming cam must be cut for this type of operation. The following steps will help the operator place the chamber in programmed operation.

1. Place the program cam on the cam hub and place the cam follower arm on the cam disc at the start point.
2. Turn ON the instrument power switches (cam switch OFF).
3. Install a new chart and ink the pen.
4. Turn the pilot switch ON.
5. Turn the circulator switch ON.
6. Turn the heat switch ON.
7. Turn the cooling switch ON.
8. After chamber has been stabilized at the start point temperature of the cam, turn the cam switch ON.
9. Select the desired shaker operation mode.

FREON 13 SYSTEM

CHARGING PROCEDURE

WHEN TO ADD: Refrigerant will need to be added when the standby pressure of the system falls sufficiently below the level recorded on the equipment serial tag (located on the electrical compartment door) that it impairs proper chamber performance.

MATERIAL REQUIRED: 1 set of manifold refrigeration gauges, three charging hoses, one tank of Freon 13.

Note: Freon 13 at ambient temperature is at a pressure exceeding 450 PSI. Extreme care should be taken in handling this gas.

CHARGING PROCEDURE:

1. Connect the charging hoses to the refrigeration gauges.
2. Connect the center charging hose to the Freon 13 tank outlet valve. (Be sure the valve is OFF.)
3. Turn the compressor discharge (#3) and suction (#2) service valves all the way counter-clockwise; back-seating the valves.
4. Connect the suction gauge hose to the compressor suction service valve (#2). Connect the discharge gauge hose to the compressor discharge service valve (#3).

5. Open the hand valves on the gauge manifold and bleed (purge) a small amount of gas through the charging hose.
6. After the hoses are purged, close the Freon 13 tank outlet valve and tighten the hose fittings on the compressor service valves.
7. Turn the compressor suction (#2) and discharge (#3) service valves clockwise (half turn only). Any charge in the system will be read on the gauges. This charge is referred to as the standby pressure. To read the proper pressure, the chamber and cascade compartment must be at ambient temperature.
8. To add gas, slowly open the outlet valve on the Freon 13 tank, allowing the higher pressure gas in the tank to flow into the refrigeration system; When the gauge reads the proper standby pressure, close the outlet valve of the Freon 13 tank.
9. Allow the unit to stand for 15 minutes and recheck the standby. It will probably be necessary to add more gas. Again, open the outlet valve on the Freon 13 tank and raise the standby to the proper level. Close the valve.
10. Allow the chamber to stand approximately 15 minutes and recheck the standby. This procedure may be followed until the proper standby is reached.

11. After the standby is reached, turn both hand valves on the manifold all the way clockwise. (frontseat).
12. With the hand valves in this position, the operating pressures of the system may be read when the equipment is running.
13. If it is desired that the gauges be removed, backseat both compressor service valves (#2 & #3) (turned all the way counter-clockwise) and remove the charging hoses.

FREON 502 SYSTEM

CHARGING PROCEDURE

WHEN TO ADD: Refrigerant will need to be added when bubbles appear in the sightglass; during pulldown after 2 minutes of operation.

MATERIALS REQUIRED: One set of manifold refrigeration gauges, three charging hoses, one tank of Freon 502.

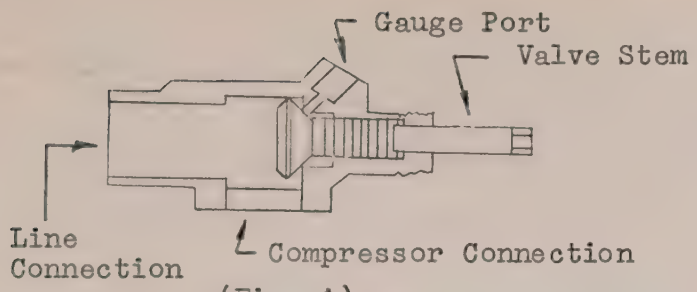
PROCEDURE:

1. Connect the three charging hoses to refrigeration gauge manifold.
2. Connect the center charging hose to the Freon 502 tank, (outlet valve of tank must be OFF).
3. Turn the suction (#2) and discharge (#3) service valves on the compressor all the way out (backseat).
4. Connect the hose from the suction gauge to the compressor suction service valve (#2). Leave the fitting loose.
5. Connect the hose from the discharge gauge to the compressor discharge service valve (#3). Leave the fitting loose.
6. Open both hand valves on the refrigeration gauge manifold.
7. Slowly open the outlet valve on the Freon 502 tank and purge the charging hoses.
8. Tighten the hose connections on the compressor suction and discharge service valves (#2 and #3).

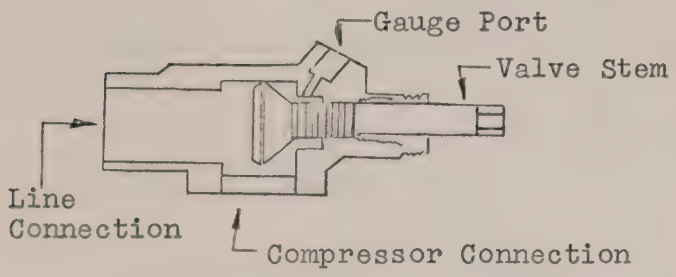
9. Turn the discharge hand valve on the refrigeration gauge manifold all the way clockwise (frontseat). The suction hand valve should remain open.
10. Turn the compressor suction (#2) and discharge (#3) service valves clockwise (half turn only). Any charge in the system will be read on the gauges.
11. Start the R-502 compressor and watch for bubbles in the sightglass. This must be checked on the pulldown after a minimum of two minutes of running.
12. Open the outlet valve on the Freon 502 tank and allow the refrigerant to flow until there are no bubbles in the sightglass.
13. Turn OFF the outlet valve on the Freon 502 tank.
14. Continue to watch the sightglass for bubbles during normal pulldown operation. If bubbles appear, more Freon 502 may have to be added.

    NOTE: If bubbles appear during the bypass operation, this does not indicate a low charge.
15. To use the gauges during compressor operation, both hand valves should be turned all the way in (frontseated).
16. To remove the gauges, turn the compressor suction (#2) and discharge (#3) service valves all the way counter-clockwise (backseat) and remove the charging hoses.

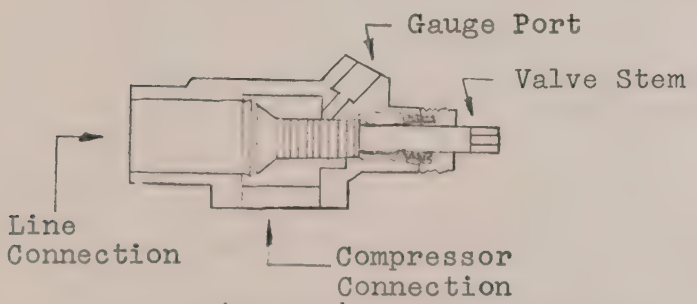
COMPRESSOR SERVICE VALVE



(Fig. 1)



(Fig. 2)



(Fig. 3)

TERMINOLOGY

Purge - Blowing out gas for the purpose of removing noncondensables.

Frontseat - To cause the valve to seat against the front valve seat, as in Fig. 3.

Backseat - To cause the valve to seat against the back valve seat, as in Fig. 1.

Charge - The amount of refrigerant in a system; to put in the refrigerant charge.

Bypass - The refrigerant is directed to a bypass heat exchanger instead of the cooling coils. This is in effect a no cooling condition.

Heat-Up - That condition where the temperature goes from a lower to a higher level.

Pull-Down-- That condition where the temperature goes from a higher level to a lower level.

In the day to day operation of this equipment, you will become aware of certain levels of noise, vibration, temperature and pressure.

If you encounter any significant changes in these levels, investigate them immediately.

You should also develop a preventive maintenance program of this equipment.

To assist in the construction of this program, Thermotron has prepared a list of preventive maintenance routines. While this list is not all inclusive, it will serve as a good base on which to build your own custom preventive maintenance program.

The establishment of such a program will add significantly to the life of the equipment and will establish the unscheduled down time on the equipment at an absolute minimum.

THERMOTRON

SUGGESTED
PREVENTIVE MAINTENANCE INTERVALS

Inspect	Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually	Routing No.
Vacuum Pump	x						1
R-502 Charge		x					2
R-13 Stand-by		x					3
Compressor Oil Level		x					4
Blower Belts & Pulleys			x				5
Circulator Motor			x				6
Humidity System			x				7
Electrical Panel			x				8
Operating Currents			x				9
Oil Pressure				x			10
Condenser (Air Cooled)				x			11
Oil Cooler					x		12
Condenser (Water-Cooled)						x	13
Tubing Abrasion			x				14

12.9.1

PREVENTIVE MAINTENANCE ROUTINE DESCRIPTIONS

1. VACUUM PUMP

The oil level should be checked each day the vacuum pump will be run. Other checks such as belt tension, RPM, oil cleanliness and others will have to be performed on an "as required" basis, depending on how much the vacuum pump is used.

2. R-502 CHARGE

Observe the sightglass to see if there are any bubbles. This should be checked during pulldown after at least 2 minutes of operation. Bubbles indicate a lack of refrigerant. If bubbles are seen during bypass operation, this does not indicate a gas shortage.

Also observe the color of the moisture indicator in the sightglass. Green is dry; yellow-green (chartreuse) is caution; and yellow indicates moisture.

3. R-13 STANDBY

If gauges are permantently attached, the standby may be read on the R-13 discharge gauge prior to the day's operation if the equipment has been turned OFF overnight.

If the equipment has been running, the chamber (and cascade section) must be at ambient temperature and equalized to read the standby pressure. The factory stand-by pressure is recorded on the serial tag located inside the electrical compartment door.

4. COMPRESSOR OIL LEVEL

With the compressors running, the oil level should be maintained halfway on the sightglass. Oil leakage should not be tolerated. Any deviation from the normal oil level should be investigated immediately.

5. BLOWER BELTS AND PULLEYS

Check the blower pulleys for rough surfaces or edges that could wear the belt. Also, check for tightness on the motor shaft. Check the belt for wear and tension.

6. CIRCULATOR MOTOR

On conventional chambers, check the rotation of the fan (suction at the grill) and check the fan for tightness on the motor shaft.

On altitude chambers, an additional check must be made to see that the oil level is maintained in the oil cups on the motor.

7. HUMIDITY SYSTEM

Check to see if the wet bulb sock is collecting any deposits from the water. This should be changed periodically depending on the water conditions. Also, make a visual inspection of the humidity system, checking for water deposits and leaks.

8. ELECTRICAL PANEL

Check for components and wires that may vibrate loose during operation. Check for signs of contactor or relay arcing. Check to see the power and ground connections remain secure.

9. OPERATING CURRENTS

With an amprobe, check the operating current of the compressors, heaters, circulators and other components. These values are shown on the electrical schematic.

10. OIL PRESSURE

The oil pressure should run from 15 to 50 PSIG above the suction pressure of the compressor. A reading below 15 PSIG should be investigated immediately.

11. AIR-COOLED CONDENSER

The air-cooled condenser should be cleaned quarterly. This period may be extended if operating conditions warrant it.

12. OIL COOLER

The oil cooler should be cleaned every six months if conditions warrant it. This period may be extended.

13. WATER-COOLED CONDENSER

Annually check the condenser for buildup of scale on the condensing surface. This interval may need to be shortened if the buildup is of a substantial amount.

14. TUBING ABRASION

Check for evidence of friction wear on all refrigeration lines. Particular care should be taken on inspecting capillary tubes to pressure switches and gauges. This check should be made each time the refrigeration machinery panels are removed.

MAINTENANCE

TROUBLESHOOTING GUIDE

Symptoms	Causes	Remedy
A. Compressor does not run.	1. Main power disengaged.	1. Close main power disconnect or equipment disconnect switch.
	2. Fuse blown.	2. Replace fuse.
	3. Contacts on compressor contactor inoperative.	3. Repair.
	4. Refrigeration reset circuit open.	4. Refer to Section M.
	5. Compressor seized.	5. If the compressor has caused the inherent overloads to trip, allow time for the compressor to cool and the inherent overloads to reset. Change one phase of the compressor power to reverse compressor rotation. Restart the compressor. If compressor will not start, notify the factory for further assistance.
	6. Contactor control circuit open.	6. Check for open control circuit.
B. Unit short cycles continuously.	1. Instrument control differential set too closely.	1. Widen differential.
	2. Time-out timer set too low.	2. Increase "Time-out" time.
C. Compressor will not start - hums intermittently. (Cycling on overload.)	1. Improperly wired.	1. Check wiring against diagram.
	2. Low line voltage.	2. Check main line voltage - determine location of voltage drop.

Symptoms	Causes	Remedy
C. (Continued)	*3. Open starting capacitor.	3. Replace starting capacitor.
	4. Open contactor contact.	4. Make physical inspection of contacts or substitute a new contactor.
	5. Open circuit in starting winding.	5. Make a continuity check of the starting winding.
	6. Stator winding grounded.	6. Make a continuity check from the stator winding to ground.
	7. High discharge pressure.	7. Check for refrigerant overcharge or noncondensables.
	8. Tight compressor.	8. Check oil level - correct binding.
D. Compressor starts, motor will not get off starting winding.	1. Low line voltage.	1. Bring up voltage.
	2. Improperly wired.	2. Check wiring against diagram.
	3. Defective start - run relay.	3. Check operation manually; replace relay if defective.
	*4. Running capacitor.	4. Check by disconnecting running capacitor.
	5. Starting and running windings shorted.	5. Check resistances. Replace stator if defective.
	6. Starting and running windings shorted.	6. Check capacitance. Replace if low.
	7. High discharge pressure.	7. Check for refrigerant overcharge or noncondensables.
	8. Tight compressor.	8. Check oil level. Check binding.

* 1 H.P. units and under.

	Symptoms		Cause		Remedy
E.	Start Run Relay burn out.	1.	Low line voltage.	1.	Increase voltage to not less than 10% under compressor motor rating.
		2.	Excessive line voltage.	2.	Reduce voltage to maximum of 10% over motor rating.
		* 3.	Incorrect running capacitor.	3.	Replace running capacitor with correct mfd. capacitance.
		4.	Short cycling.	4.	Reduce number starts per hour. (See Section B.)
		5.	Incorrect mounting.	5.	Mount relay in correct position.
		6.	Incorrect relay.	6.	Use relay properly selected for motor characteristics.
		7.	Relay vibrating.	7.	Mount relay in rigid location.
F.	Insufficient cooling effect.	1.	Refrigerant shortage.	1.	Repair leak and recharge.
		2.	Frosted coil.	2.	Defrost and dry coil.
		3.	Low air circulation.	3.	Check fan rotation.
		4.	Compressor inefficient.	4.	Check for tightness of defective valves.
		5.	Cooling coils obstructed.	5.	Remove obstruction.
G.	R-13 Head Pressure too high.	1.	Refrigerant overcharge.	1.	Purge.
		2.	Air in system.	2.	Purge.
		3.	R-502 system short or gas.	3.	Repair leak and recharge.

* 1 H.P. units and under.

	Symptoms		Cause		Remedy
H.	R-13 Head Pressure too low.	1.	Refrigerant shortage	1.	Repair leak and recharge.
		2.	Compressor suction or discharge valves inefficient.	2.	Clean or replace leaky valve plates.
I.	R-502 Head Pressure too high.	1.	Condensing water (air) too warm.	1.	Supply cooling water (air).
		2.	Restricted water (air) cooled condenser.	2.	Clean or replace condenser.
		3.	Water valve too far closed.	3.	Adjust valve for 200# head pressure.
		4.	Air in system.	4.	Purge.
J.	R-502 Head Pressure too low.	1.	Condensing water (air) too cold.	1.	Adjust water valve for 200# head pressure.
K.	Noisy unit.	1.	Insufficient compressor oil.	1.	Add oil to proper level.
		2.	Tubing rattle.	2.	Bend tubes away from contact.
		3.	Mountings loose.	3.	Tighten.
		4.	Oil slugging or refrigerant flooding back.	4.	Correct cause of floodback.
L.	Compressor loses oil.	1.	Shortage of refrigerant.	1.	Repair leak and recharge.
		2.	Machinery section remote or system change made.	2.	Add oil until sight-glass is half full when running.

	Symptoms		Cause		Remedy
L.	(Continued)	3.	Short cycling.	3.	Refer to Part B.
		4.	Superheat too high at compressor suction.	4.	Change location of expansion valve bulb or adjust valve to return wet gas to compressor.
M.	Refrigeration reset light ON.	1.	Nuisance tripping due to line fluctuation.	1.	Check line with a voltmeter or recorder.
		2.	Solid state module failure drop-out.	2.	Check for excessive vibration on compressor. Install new module.
		3.	Inherent overload protection open. (R-13 or R-502 system)	3.	These protectors require approximately 15 minutes to reset. After 15 minutes, reset and measure the three phase compressor current.
		4.	R-13 discharge temperature limit open.	4.	This thermostat requires approximately 3 minutes to reset. If the R-13 unit is open, check to see if the R-13 injection valve is feeding. Also, check the R-13 standby.
		5.	R-502 discharge temperature limit open.	5.	Check the R-502 charge.
		6.	R-13 or R-502 oil differential switch open.	6.	Reset and check compressor oil level. If tripping occurs, contact the factory for assistance.

Symptoms	Cause	Remedy
M. (Continued)	7. R-13 Hi-Lo Pressure switch open.	7. Open on low-chec the R-13 standby pressure. Also check the rotati of the circulato fan. Open on hi check the R-502 sightglass for bubbles (indicat ing a low charge
	8. R-502 Hi-Lo Pressure switch open.	8. Open on high - check the refrig eartion water supply. Open on low - check the R-502 charge.
	9. Crankcase thermostat open.	9. Allow sufficient time for the cra case heater to w the oil. Crankca heater could be open or the cran case thermostat defective.

Form PTS-23000

PARAGON PROGRAM TIME SWITCH

TIMER APPLICATION:

The Paragon Program Time Switch is a 24-hour programming device. Its application in environmental testing is to provide a signal for actuating control relays of contactors. These relays control such actions as ON-OFF control of shaker tables, instrument cams, or product control circuits. In this manner, the control of these various actions is accomplished in an independent operation from the temperature controlling instrument.

OPERATION:

Before attempting to operate this timer, read the instructions on the inside of the timer case. Programming is accomplished by inserting trippers in the slots provided in the 24-hour timer dial. The dial is divided into five minute increments, so this is the smallest time division that may be programmed. The trippers are of two basic types. These are the whole trippers and half trippers.

P/N 14308 Half Tripper

P/N 12400 Whole Tripper

The whole tripper provides actuation to both timer switches at the same time. The half tripper will actuate only one switch, depending on which way it is facing.

The tripper, by depressing the switch, provides a signal pulse. This pulse is adjustable from 4 to 60 seconds on the signal cam located on the lower left hand corner of the timer. In our application, the pulse duration is of no consequence so it is normally adjusted for a 4 second pulse.

The pulse is used to energize a latching relay which provides ON-OFF control to the circuit involved.

The timer is provided with an auto-manual-off switch. The manual position is used to manually step the timer to place it in the proper sequence of operation. This is a spring return position, and the lever will return to the automatic position when released. In the automatic position, the timer will actuate the switches each time the tripper depresses them. Each actuation provides a pulse to control some function of the program requirement. In the OFF position, the timer dial will still advance, but the switches will not energize when they are depressed by the trippers.

The shaker will be programmed as previously described, with the following exception - the hourly trippers will be whole trippers. In addition, half trippers will have to be placed half-way between the hour graduations to actuate the product control switch.

The following sequence of events will occur. After the timer has been positioned to the start of the program cycle, the timer will advance until the half tripper at the 30 minutes division energizes the product control switch and turns on the power to the product. As the timer advances to the 50 minutes increment, the shaker will be energized by the tripper on the clock. As the timer advances to the first hour tripper (double tripper) both switches are again activated and the product power and the shaker power are turned OFF.

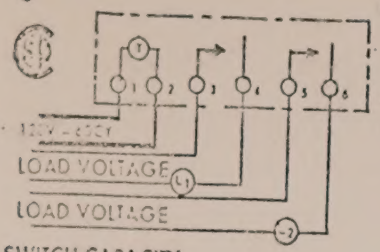
In this manner, it is possible to program any number of functions into a test cycle program. One switch is required for each control function. If there are three functions, two timers are needed. One will have two switches, and the other one switch.

To perform the entire test program, the timers must be synchronized with the control temperature instrument. In this manner, the program can be run in a fully automatic operation.

Program Instrument

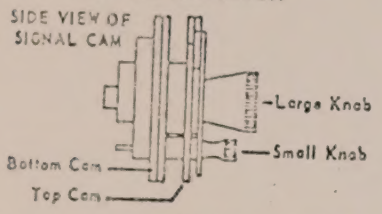
MODEL 23002-OS

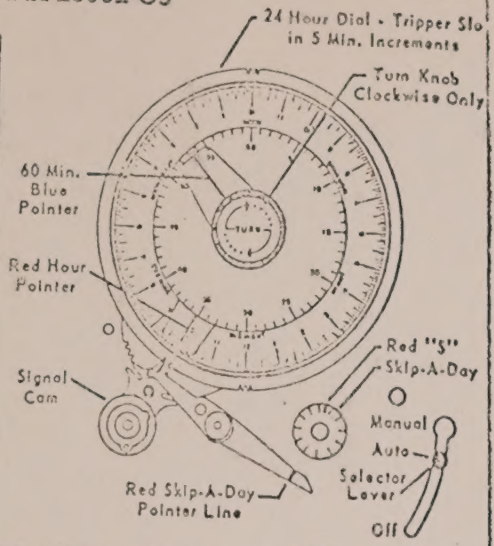
C-278
Rev.



SWITCH CAPACITY

S.P.S.T. 5 AMP 125 VA. 120-240V. 60CY.
TIMING MOTOR: 120V. 60CY.





PRECISION INSTRUMENT - TO INSURE PROPER OPERATION
PLEASE FOLLOW INSTRUCTIONS

1. TO SET SIGNAL CAMS:
   A. No. 1 signal adjustable 4-60 sec. on bottom cam. To set:
      1. Loosen large knob on signal cam, then turn small knob CLOCKWISE to increase length or COUNTER CLOCKWISE to shorten length of signal.
   B. No. 2 signal (adjustable 4-60 sec. in length).
      1. Fan out top cam for length of signal.
   C. Tighten large knob while holding top and bottom cams to fix position of cams.
2. PROGRAM SELECTION Circuit closure in 5 minute graduations.
   A. Use regular tripper for No. 1 signal and No. 2 signal.
   B. Use half tripper facing back for No. 1 signal only or facing out for No. 2 signal only.
   C. To set programs, insert trippers into slots on 24 hour dial. BE SURE TO INSERT PINS ALL THE WAY.
3. TIME OF DAY Turn knob on 60 minute silver dial CLOCKWISE to advance 24 hour black dial to within one hour of time of day (red pointer). Turn signal cam COUNTER CLOCKWISE for vernier adjustment of blue pointer to exact minute.
4. SKIP-A-DAY SETTING (Day and/or night signal omission).
   A. Each day of the week is divided into two periods – day - 6 A.M. to 6 P.M. night - 6 P.M. to 6 A.M. Sunday indicated by red "S". To skip a 12 hour period, insert proper tripper into slot on skip-a-day wheel.
   B. To position, turn SKIP-A-DAY wheel in CLOCKWISE direction only until proper day of week slot is opposite red SKIP-A-DAY pointer line. (See enlarged detail above.)
5. MANUAL OPERATION Use selector lever.
6. TO REMOVE MOVEMENT Take off terminal board cover, press spring tab at top of case, very carefully lift unit out and upward. To replace, fit plate in side slots and press inward at top. Replace terminal board cover.
7. DAYLIGHT SAVING TIME Move selector lever to "OFF".
   A. Advance time ahead one hour – move selector lever to "AUTO" position.
   B. To set back for standard time, advance timer ahead 23 hours, adjust skip-a-day setting for correct day of week – move selector lever to the "AUTO" position or disconnect power for approximately 70 minutes and reset dial to time of day.

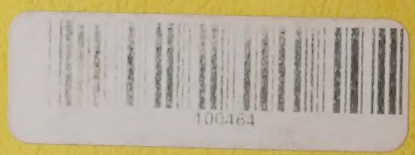
For service, return to nearest Paragon Authorized Service Center.

Made in the U.S.A. by

AMF

PARAGON ELECTRIC COMPANY, INC.
1600 12th Street, Two Rivers, Wisconsin 54241
Subsidiary of AMF INCORPORATED Printed in U.S.A.

THERMOTRON
CORPORATION



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